County of Santa Cruz

Climate Action Strategy

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Prepared by:

County of Santa Cruz, Planning Department
701 Ocean Street, 4th Floor
Santa Cruz, CA 95060
www.sccoplanning.com

Approved by:

County of Santa Cruz Board of Supervisors
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Acknowledgements

Principal Authors:

David Carlson, Planning Department
Todd Sexauer, Planning Department

County of Santa Cruz

Board of Supervisors

John Leopold, 1st District
Zach Friend, 2nd District
Neal Coonerty, 3rd District
Greg Caput, 4th District
Bruce McPherson, 5th District
Ellen Pirie, 2nd District (former)
Mark Stone, 5th District (former)

Commission on the Environment

Greg Pepping and Dan Haifley, 1st District
Sharon Sarris and Kenneth Adelman, 2nd District
Ross Clark and Laura Kasa, 3rd District
Bob Culbertson and Robert Ketley, 4th District
Virginia Johnson and Dr. Betsy Herbert, 5th District

Planning Department

Kathleen Molloy Previsich, Director
Paia Levine, Principal Planner
David Carlson, Resource Planner
Todd Sexauer, Environmental Planner
Maya Wagoner, Planning Intern

General Services Department

Nancy Gordon, Director
Joshua Reilly, County Safety Officer
Michael Derosa, Fleet Services
Carol Johnson, Administrative Services Manager
Anthony Loero, Building maintenance Superintendent,
Tom Hambleton, Fleet Services manager,
William Kersten, Building Maintenance Superintendent

Information Services Department

Tom Melkonian, Assistant Programming Analyst

Health Services Agency

John Ricker, Water Resources Division Director
Chris Coburn, Resource Planner

Department of Public Works

Steve Wiesner, Assistant Director
Kasey Kolassa, Recycling and Solid Waste Services Manager
Tim Goncharoff, Resource Planner
Glenn DiOrio, Assistant Public Works Supt. FMD
Mike Torrecillas, Disposal Site Assistant Superintendent
Wendy Fisher, Sr. Account Clerk
Ana Maria Rebelo, Sustainability Program Coordinator

County of Santa Cruz (continued)

Office of Emergency Services

Paul Horvat, Emergency Service Manager

County Assessor's Office

Michael Herbert, Information Systems Analyst

County Administrative Office

Susan Pearlman, Principal Administrative Analyst

Agricultural Commissioner

Mary Lou Nicoletti, Agricultural Commissioner

Association of Monterey Bay Area Governments

Elisabeth Russell, Special Projects Manager
Chris Sentieri, Special Projects Associate
Charlie Buck, Special Projects Associate

Monterey Bay Unified Air Pollution Control District

David Craft, Air Pollution Engineer

University of California, Santa Cruz

Gary B. Griggs, PhD, Director of the Institute of Marine Sciences
Brent Haddad, PhD, Associate Dean of Engineering for Technology Management

University of California, Davis

V. Ryan Haden, PhD, Land, Air and Water Resources

University of California Cooperative Extension, Santa Cruz County

Laura Tourte, Farm Management Advisor

Private Organizations

Amelia Conlen, People Power
Lauren Dockendorf, Save Our Shores
Sacha Lozano, Resource Conservation District of Santa Cruz County
Michael Levy, Transition Santa Cruz
Jack Nelson, Campaign for Sensible Transportation
Greg Pepping, Coastal Watershed Council
Nik Strong-Cvetich, Resource Conservation District of Santa Cruz County
Jess Brown, Santa Cruz County Farm Bureau

Pacific Gas & Electric

Green Communities Program

Executive Summary

Californians are already experiencing impacts from climate change (California Natural Resources Agency, 2009), and a wide variety of impacts are likely to be felt with increasing magnitude as the concentration of greenhouse gases (GHGs) in the atmosphere continues to rise (City of Santa Cruz, 2011). The first portion of this Climate Action Strategy (CAS) reports the results of the GHG emissions inventory for Santa Cruz County, proposes targets for GHG reduction, and outlines strategies and implementing actions to achieve the targets. The second portion focuses on vulnerability assessment and strategies for adapting to the types of impacts that are likely to occur in Santa Cruz County. The CAS incorporates input from the local community and non- governmental agencies that are working to mitigate and respond to climate change.

GHG emissions inventories were prepared for County government operations and for community activities for 2005 and updated for 2009. Total emissions for government operations in 2009 were approximately 34,000 metric tons of CO_2 equivalent (CO_2e), a decrease of 12 percent from 2005. Total emissions for community activities were approximately 1,030,000 metric tons in 2009, a decrease of more than 50 percent from 2005. The dramatic decrease in community emissions reflects the closure of the Davenport cement plant, which accounted for approximately 90 percent of the commercial/industrial emissions in 2005. The inventories indicate that 70 percent of the community emissions in 2009 were generated by the transportation sector. A separate, simplified inventory of GHG emissions from agricultural activity was prepared for 2011. Agricultural emissions other than electricity emissions were in the range of 17,000 metric tons of CO_2e. This represents, at most, two percent of GHG emissions countywide (2009 data).

State legislation requires California to reduce GHG emissions to 1990 levels by 2020. Based on our 2005 community emissions inventory, 1990 emissions levels for Santa Cruz County were estimated. Santa Cruz County has already met the target for 2020 due to the closing of the Davenport cement plant. The State has also set a long-term reduction target for 2050, which is 80 percent below 1990 levels. This CAS incorporates the two state targets and sets an interim target for 2035. A “business as usual” estimate of future emissions is used to gauge the amount of effort required to meet the reduction targets.

GHG reduction strategies are proposed for the three sectors with the highest emissions: transportation, energy, and solid waste. The amount of emissions reductions that can be expected from each strategy is estimated. Calculations indicate that the emissions targets for 2035 and 2050 can be met, but that a sustained commitment to full implementation of the strategies will be required. The largest reduction will come from state and federal standards for fuel efficiency and vehicle emissions and from the California renewable energy portfolio standard (58 percent), followed by a cleaner energy supply from Community Choice Aggregation (CCA) if that type of regional energy authority is formed (22 percent), energy efficiency (9 percent), transportation and land use planning (5 percent), green business (3 percent), and electric vehicles (3 percent). If a CCA is not feasible the gap may be closed with greater reductions from other strategies, including a method to provide incentives for local renewable power and energy conservation similar to what a CCA would provide. Priority for implementation will be a function of the estimated potential for emissions reduction, cost to implement, and co-benefits of each strategy.

A plan for monitoring the implementation of emissions reduction is introduced, which includes identifying the group with responsibility for implementation, periodic reporting, and a recommendation for updating the GHG emissions inventories every five years.

A vulnerability assessment was prepared to identify the conditions that may occur in Santa Cruz County as a result of the various components of climate change (increasing temperature, rising sea level, and shifts in the

precipitation regime) and the locations, infrastructure and economic sectors that are particularly vulnerable to negative impacts.

The assessment identifies the coastal areas that are most susceptible to increased flooding, storm surge, beach and coastal bluff erosion from winter storms. Winter storm damage may become more frequent than in the past as a result of heightened sea levels persisting longer as sea level rises (Cayan et al., 2008; Cloern et al., 2011), and precipitation that is concentrated in fewer months each year (Flint, L.E., and Flint, A.L., 2012). The analysis is based on 16–66 inches (42–167 cm.) of sea level rise by 2100, as forecast by the National Academy of Sciences (National Research Council, 2012). Inundation, rising groundwater, and increased saltwater intrusion into groundwater will also affect low-lying areas. The systems that will be most affected are residential coastal property, wastewater treatment infrastructure, coastal roads and bridges, beaches, coastal and wetland ecosystems, and water supply from coastal wells.

The vulnerability assessment also identifies potential effects of precipitation changes and increased temperature of between 3.6–7.2 degrees Fahrenheit (2–4 degrees Celsius) (Flint, L.E., and Flint, A.L., 2012) on water supply, wildfire, biodiversity, and public health. Particular attention is given to the significant decrease in redwood habitat that may occur, especially if the current trend of decreasing coastal fog continues (Flint, L.E., and Flint, A.L., 2012).

Tourism and agriculture, two top revenue producing and job generating sectors of the local economy, are closely tied to the climate and are therefore vulnerable to climate change. Tourism relies on beaches, coastal attractions, redwoods, and vulnerable infrastructure for access to and around the coast. Agriculture will be affected by increases in temperature, changing pest patterns, changing fog dynamics, and increased potential for both flood and drought.

A risk analysis was performed to determine which impacts from climate change present the greatest risk to people and to the natural and built environments. In the short to intermediate term (2010–2050) water shortage was identified as the largest risk. In the intermediate to long term (2050–2100) rising water table, coastal bluff erosion, and increased flooding and landslides join water shortage as the greatest risks.

Eight “climate adaptation goals” are articulated as a guide for evaluating adaptation strategies. Specific adaptation strategies are proposed that include new actions as well as acknowledgement of existing plans and programs, which, while not explicitly about climate change, address the salient issues. Some proposed strategies emphasize avoidance of hazards while others focus on future planning efforts and specific engineering solutions to protect existing development. However, all emphasize building connections among people and among organizations to accomplish the climate adaptation goals in a framework of partnership.

It is expected that this CAS will be modified periodically as scientific research progresses, new information becomes available and new ideas and priorities are brought forward as more people become involved in responding to climate change in Santa Cruz County.

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1.0 Introduction

1.1 The Changing Climate and the Need for Action

Climate change refers to a long term shift in the temperature, precipitation, and seasonal patterns in the weather. Direct observations around the globe indicate that warming of the earth's climate system is underway (Cal-Adapt, 2012b). Climate change is currently affecting California, where sea level has risen by as much as seven inches along the coast over the last century, increasing pressure on the state's infrastructure, water supplies, and natural resources. The state has seen increased average temperatures, more extreme hot days, fewer cold nights, shifts in the water cycle with less winter precipitation falling as snow, and snowmelt running off sooner in the year (California Natural Resources Agency, 2009). These are only some of the changes that have occurred.

There is consensus among the world's leading climate change scientists that human-generated emissions of heat-trapping greenhouse gases (GHGs) are the primary cause of the warming trend. Projections indicate that atmospheric concentrations of GHGs will continue to increase throughout this century. Data describing atmospheric GHG concentrations over the past 800,000 years demonstrates that concentrations of carbon dioxide (CO_2), the primary anthropogenic GHG, have increased substantially since pre-industrial times, from approximately 280 parts per million (ppm) prior to the industrial revolution in the mid 1800's to approximately 353 ppm in 1990 and approximately 379 ppm in 2005 (California Natural Resources Agency, 2009).

In 2000, the Intergovernmental Panel on Climate Change (IPCC, 2000) described potential global emission scenarios for the coming century. The scenarios vary from a best-case, characterized by low population growth, clean technologies, and low GHG emissions; to a worst-case, wherein high population and fossil-fuel dependence result in extreme levels of GHG emissions. While some degree of climate change is inevitable, most climate scientists agree that in order to avoid dangerous climate change, atmospheric GHG concentrations must be stabilized at 350-400 ppm (California Natural Resources Agency 2009).

Our natural, economic, and cultural systems are closely tied to the climate. Significant changes in the climate will impact the way people live: the food we grow, our health and safety, the availability of water, our economy, wildlife and vegetation, and many other aspects of our lives. Preparation of a Climate Action Strategy (CAS) is an opportunity for the community to review the local activities that contribute to GHG emissions, to consider changes we can make to decrease our local contribution to climate change, and to plan the community response to the local impacts that will occur as climate change progresses.

1.2 Purpose of the Climate Action Strategy

Efforts to reduce human contributions to climate change are underway in California at the state, regional and local levels. Each level of government has a particular role in the overall effort. The CAS serves as a framework for the actions that the County of Santa Cruz and the unincorporated community can take to both lessen our contribution to climate change and prepare for the impacts when they do occur. In addition to guiding County government actions, the CAS is intended to inspire non-government community organizations in their efforts to address climate change, and to identify opportunities for partnerships with other government agencies and community groups.

The CAS outlines a course of action to reduce GHG emissions produced by governmental operations and community activities within unincorporated Santa Cruz County. Implementation of the CAS will build on the fact

that Santa Cruz County has already met the 2020 emissions reduction target recommended by the state[1] and will set the County on a path toward reducing emissions to 59 percent below 2009 levels by 2050.

This document also describes the particular ways in which Santa Cruz County may be vulnerable to impacts of climate change, and suggests adaptation strategies for further consideration and implementation. Adaptation to climate change will be an ongoing process as the type and severity of potential impacts become more clear. While it is important to position County government and the community to plan for the changes that may occur, to make current decisions with consideration and understanding of how conditions may change as climate change proceeds, and to respond to impacts when they do occur, conditions will change gradually, and therefore there is time to form the partnerships and collect information that will contribute to a well planned, adaptive response.

1.3 California Legislative Context

In 2005 Governor Schwarzenegger signed Executive Order S-3-05, proclaiming that California is vulnerable to the effects of climate change, including reduced snowpack in the Sierra Nevada Mountains, exacerbated air quality problems, and sea level rise. To address these concerns, the executive order established targets for total GHG emissions which include reducing GHG emissions to 2000 levels by 2010, to 1990 levels by 2020, and to 80 percent below 1990 levels by 2050.

In 2006 Governor Schwarzenegger signed Assembly Bill (AB) 32, the California Global Warming Solutions Act of 2006. AB 32 requires California to reduce statewide GHG emissions to 1990 levels by 2020. AB 32 does not set reduction requirements for the year 2050.

In 2008 the California Air Resources Board (CARB) approved the "Climate Change Scoping Plan", which outlines the state's plan to achieve GHG reductions in California required by AB 32. The Scoping Plan describes the strategies California will use to reduce GHG emissions by 169 million metric tons of CO_2 equivalent (CO_2e)[2]; a level that is approximately 30 percent below the state's

California Climate Policy Summary

Executive Order S-03-05. The initial push for greenhouse gas reduction was set in motion by Executive Order S-03-05 in 2005, which established greenhouse gas emission reduction targets.

AB 32 – Global Warming Solutions Act. In 2006 the California legislature passed and the Governor signed Assembly Bill (AB) 32, known as the California Global Warming Solutions Act. The law established a comprehensive program to achieve quantifiable, cost-effective reductions of greenhouse gases on a scheduled basis. It required the California Air Resources Board (ARB) to develop regulations and market mechanisms that would ultimately reduce California's greenhouse gas emissions by 25 percent by 2020. It required the ARB to adopt a plan by January 1, 2009, indicating how emission reductions would be achieved from significant greenhouse gas sources, and to adopt regulations by January 1, 2011 to achieve maximum technologically feasible and cost-effective reductions in greenhouse gas. Mandatory caps would be set in 2012 for significant sources.

SB 97 – CEQA Guidelines for Mitigating Greenhouse Gas Emissions. Also in 2006 the legislature passed Senate Bill 97 which directed the Governor's Office of Planning and Research (OPR) to develop draft CEQA Guidelines "for mitigation of greenhouse gas emissions for the effects of greenhouse gas emissions by July 1, 2009. The CEQA Guidelines Amendments, adopted by the California Natural Resources Agency on December 30, 2009, provide guidance to public agencies regarding analysis and mitigation of greenhouse gas emissions in draft CEQA documents.

SB 375 – Sustainable Communities and Climate Protection Act. In 2008 the legislature passed SB 375 which built upon AB 32 by connecting the reduction of greenhouse gas emissions from cars and light trucks to regional and local land use and transportation planning. SB 375 requires the California Air Resources Board to establish greenhouse gas emissions reduction targets for each region, and each metropolitan planning organization (MPO) to create a Sustainable Communities Strategy (SCS) as part of the Regional Transportation Plan (RTP) to meet regional emissions reduction targets.

Source: State of California 2012a

[1] Largely due to the cessation of manufacturing activity at the Davenport cement plant. See emissions inventories in Appendix G.

[2] There are many gases that contribute to the greenhouse effect, including CO_2 (Carbon Dioxide), CH_4 (methane), NO_2 (Nitrogen Dioxide) and others. Some of these gases are more powerful modifiers of the atmosphere than others. Therefore, the term CO_2e (carbon dioxide equivalent) will be used throughout this report as the standard measurement for greenhouse gas accounting. For example, CH_4 is 21 times more powerful than CO_2 as a greenhouse gas, and therefore one unit of CH_4 may be expressed as 21 CO_2e.

projected 2020 emission level under a "business-as-usual" scenario. The Scoping Plan also identifies recommended GHG reductions and strategies to achieve the reductions for each sector, or category of activity, in the state's GHG inventory. The key elements of the State of California Climate Change Scoping Plan strategies include:

- Expanding and strengthening existing energy efficiency programs as well as building and appliance standards;
- Achieving a statewide renewable energy mix of 33 percent;
- Developing a California cap-and-trade program that links with other Western Climate Initiative partner programs to create a regional market system;
- Establishing targets for transportation-related greenhouse gas emissions for regions throughout California and pursuing policies and incentives to achieve those targets;
- Adopting and implementing measures pursuant to existing state laws and policies, including California's clean car standards, goods movement measures, and the Low Carbon Fuel Standard; and
- Creating targeted fees, including a public goods charge on water use, fees on high global warming potential gases, and a fee to fund the administration costs of the state's long-term commitment to AB 32 implementation

(California Air Resources Board, 2008).

The state acknowledges that local government will play an important role in achieving California's long-term GHG reduction goals. Cities and counties have sole or partial jurisdiction over a wide range of factors that will affect GHG emissions within the transportation, housing, industry, forestry, water, agriculture, electricity, and natural gas sectors. In the Scoping Plan, CARB encourages local governments to adopt reduction targets for municipal operations emissions and community-wide emissions that parallel the state's climate protection efforts. CARB has also provided guidance for cities and counties to reduce community-wide emissions to 15 percent below 2005 levels by 2020.

Governor Arnold Schwarzenegger signed Executive Order S-13-08 on November 14, 2008. The order called on state agencies to develop California's first adaptation strategy to identify and prepare for these expected climate impacts. In 2009, California adopted a statewide Climate Adaptation Strategy that summarizes climate change impacts and recommends adaptation strategies across seven sectors: Public Health, Biodiversity and Habitat, Oceans and Coastal Resources, Water, Agriculture, Forestry, and Transportation and Energy. The 2009 California Climate Adaptation Strategy was the first to use downscaled climate models to more accurately assess statewide climate impacts as a basis for providing guidance for establishing actions that prepare, prevent, and respond to the effects of climate change.

1.4 Scope of the Climate Action Strategy

The first step in developing this strategy was the preparation of detailed inventories of GHG emissions produced by County government and community activities. The inventories establish the current, or baseline, level of GHG emissions. The inventories also identify which activities produce the largest share of emissions, so that efforts to reduce emissions can be focused effectively. The Santa Cruz County inventories were accepted by the Board of Supervisors on January 24, 2012.

By analyzing the baseline emissions and making reasonable assumptions about population growth and other factors, it is possible to estimate future emissions. Once an estimate, or projection, of future emissions is in place it is possible to set realistic goals for reducing emissions. Specific targets are helpful to foster government and community commitment and to guide planning and implementation. The emission reduction targets in the CAS apply to both County government operations and the unincorporated County as a whole. The inventories and the

forecast of future emissions are benchmarks against which the County can measure progress toward the targets set out in this CAS.

The CAS articulates a broad strategy for reaching emission reduction goals, and then goes further to identify the individual programs, policies, and initiatives that, together, will move County operations and the community toward the goals. Strategies are included to reduce emissions in the major focus areas of transportation, energy, and solid waste. These strategies represent current thinking, and there are many more possible actions and ways in which the community may choose to respond to climate change. It is expected that this document will be updated regularly, and that the strategies section of this document will evolve as the strategies are tested and additional ideas are suggested.

The CAS identifies the parties that would carry out the various emissions reduction and adaptation strategies, with performance indicators for most strategies. The GHG inventories will be updated periodically in order to measure whether strategies are on track to produce the reductions that have been forecast. As data is collected and community partnerships are expanded, the County will work with the responsible parties and the public to add, subtract, and modify the strategies as needed to meet our emissions reduction goals.

There is growing recognition that climate change is already underway and the scientific research indicates that additional impacts are inevitable even with mitigation efforts (California Natural Resources Agency 2009). Efforts to reduce GHG emissions are intended to mitigate the severity of climate change. Adaptation refers to resilience and the ability to respond to the impacts when they occur. Both mitigation and adaptation are necessary. Santa Cruz County has already begun planning for climate change through the Integrated Regional Water Management Plan and other activities, including participation in the Monterey Bay Sea Level Rise Vulnerability Assessment. The CAS describes these projects and the additional planning required to complete a comprehensive strategy to reduce the vulnerability of the County's natural and human systems, including our water supply, public infrastructure, economy, coastal resources, wildlife and vegetation, health and overall quality of life.

1.5 Community Participation

Ideas and feedback from the community, both from groups that are involved in climate action work and the general public, contributed significantly to this document. In addition to presentations of the Preliminary Draft CAS to the Board of Supervisors and the County Commission on the Environment at noticed public hearings, the CAS was the subject of a community meeting and meetings with local organizations working in the climate action arena and with representatives of agriculture, including the Santa Cruz County Farm Bureau and University of California Cooperative Extension. There was outreach to the business community in the context of renewable energy and energy efficiency financing, which included local financial institutions, solar installers, the Chamber of Commerce, and commercial property owners. A web page has also been created, which includes a brief explanation of the CAS, a link to the document, and an online tool for providing feedback called "Open Town Hall".

The comments from the community and focus group meetings are listed in Appendix F, which also indicates the additions and modifications that were made in response to the comments. The CAS has been expanded from the scope of the Preliminary Draft to include information on agricultural emissions and the role of forest lands in carbon sequestration, to include Appendix G which gives additional detail about the process of creating the emissions inventory, and, in recognition of the importance of planning for the community to become more resilient to the effects of climate change, the CAS now includes a vulnerability assessment (Chapter 5), risk analysis (Chapter 6) and strategies for adaptation (Chapter 7).

This document benefitted from the fact that the City of Santa Cruz was completing a public comment process on climate action just as this study was initiated. The results of the City's process assisted with anticipating the community's interests with respect to climate action planning. It also furthered the goal of having a generally

consistent approach to climate change throughout the County, which will be especially useful as we move forward with cooperative efforts with partner cities and other organizations and institutions.

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2.0 Greenhouse Gas Emissions Inventories and Emissions Reduction Targets

Greenhouse gas emissions inventories are tools for estimating and documenting the sources of emissions and the relative amount of emissions produced by different activities, referred to as sectors. The inventories direct us toward the actions that will be most effective at reducing emissions for the unique circumstances of Santa Cruz County. Inventories also provide the accurate baseline of emissions that is necessary for setting an emissions reduction target and for measuring progress over time.

Inventories of emissions from County government operations and from community activities were originally prepared for 2005, which is a commonly accepted baseline year in California (California Air Resources Board, 2008). An update of each inventory has been prepared for 2009, the latest year in which a complete data set is available. Preparing the inventories involved close coordination with staff from the County General Services and Public Works Departments, and numerous contacts with other County, regional and state agencies during the data gathering and analysis process.

It must be noted that GHG inventory results should not be considered absolute amounts of emissions, particularly for the community inventory, because the inventories do not include all possible emissions and the emissions that are counted have been estimated to varying degrees of accuracy. Emissions that are not included are those that are very difficult to measure accurately, such as emissions from rural propane use. However, the inventories do give a reasonably accurate picture of the relative amounts of emissions being generated by different activities, in a manner that can be tracked over time to measure trends in overall emissions.

Lastly, it is important to recognize that a large portion of GHGs produced around the world are connected to producing goods for export. Some of those goods are consumed in Santa Cruz County, but the emissions from their production and transport are not captured in our local inventory. It is useful to keep those externalized emissions in mind as we develop our response to climate change as there are strategies, such as encouraging "buy local" principles for consumption of local goods. These involve generally lower GHG emissions associated with production and transport, which can begin to address those external emissions.

2.1 Government Operations Inventory

Table 2-1 and the accompanying graph (Figure 2-1) provide a summary of the GHG emissions inventories for Santa Cruz County government operations in 2005 and 2009. In 2005, total emissions were about 39,000 metric tons of carbon dioxide equivalent (CO_2e), falling to about 34,000 metric tons CO_2e in 2009. Even with an efficient landfill gas collection system, the largest contribution of GHG emissions in the government operations inventory is from the decomposition of solid waste that is releasing methane into the atmosphere as it decomposes in the Buena Vista Landfill and the Ben Lomond Transfer Station. The next three highest sectors, employee commute, buildings and facilities, and vehicle fleet, produce fairly similar levels of emissions. The County, largely through the General Services Department and Department of Public Works, has a number of successful programs in place that are operating to moderate GHG emissions (see Appendix A).

While County government operations are the activities over which the Board of Supervisors has the most direct influence, they represent a very small portion of the overall emissions generated in the unincorporated area. For comparison, approximately four percent of the total community emissions in 2009 were attributable to the

County's own operations. This draws the focus of emissions reduction activity to the community inventory, and particularly to the transportation sector.

Table 2-1:
Government Operations Emissions by Sector

Sector	Metric Tons CO_2e Emitted		Percent Change from 2005 Baseline
	Year 2005	Year 2009	
Solid Waste Facilities	20,261	18,335	-10%
Employee Commute	6,928	5,370(1)	-22%(1)
Buildings and Facilities	5,525	5,847	6%
Vehicle Fleet	5,253	3,673	-30%
Wastewater Treatment Facilities	848	941	11%
Public Lighting	62	69	11%
Water Delivery	24	32	33%
Total	**38,901**	**34,267**	**-12%**

Note:
(1) The reduction in emissions from the employee commute is largely due to a reduction in employees between 2005 and 2009.
Source: County of Santa Cruz, 2012.

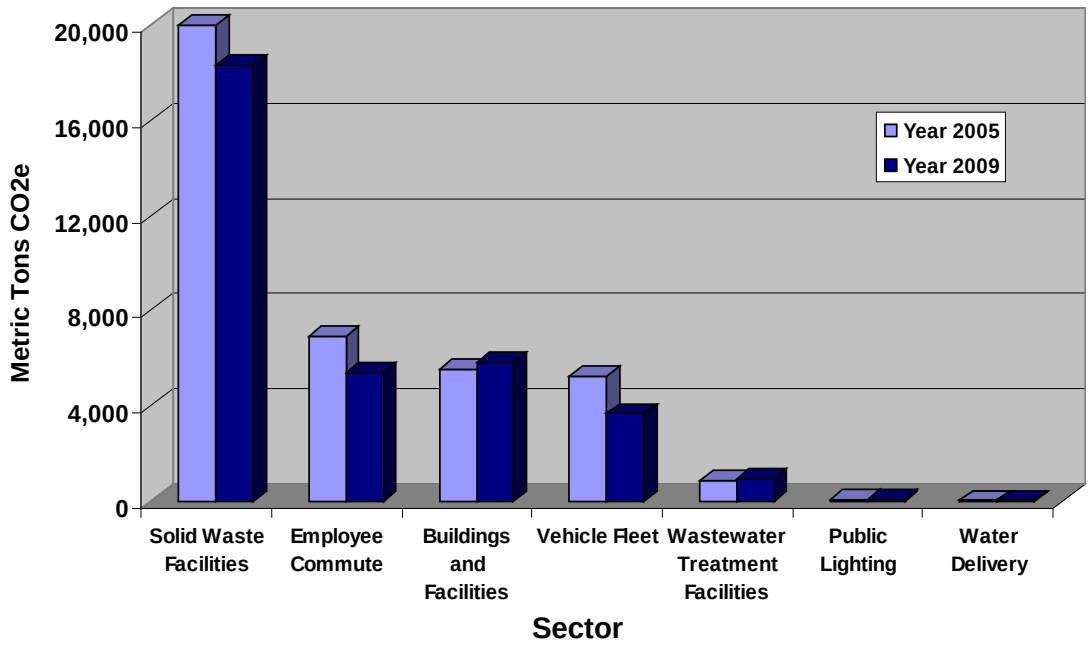

Figure 2-1: Government Operations Emissions by Sector

Source: County of Santa Cruz, 2012.

2.2 Community Inventory

Table 2-2 and the accompanying figure (Figure 2-2) provide a summary of community-wide GHG emissions in 2005 and 2009. The community inventory includes greenhouse gas emissions from the use of electricity and natural gas in residences and businesses in the unincorporated portions of Santa Cruz County. It also includes emissions from vehicles traveling on local roads and state highways in the unincorporated portions of the County. In 2005, Santa Cruz County's total community-wide GHG emissions were about 1.9 million metric tons of CO_2e. Emissions from the Davenport cement plant accounted for about half this total. The 2009 emissions inventory shows a very dramatic reduction in the commercial and industrial sector, which reflects the closure of the cement plant in Davenport. The 2009 inventory shows less dramatic changes in other sectors, including reductions in the transportation and solid waste sectors and an increase in the residential sector.

The 2009 inventory shows the vast majority (60 percent) of community emissions in 2009 come from the transportation sector, which points to fuel use and Vehicle Miles Traveled (VMT) as very significant contributors to our local emissions picture. VMT decreased slightly between 2005 and 2009, probably due to the poor economy and higher fuel prices. According the California Employment Development Department, the annual unemployment rate in Santa Cruz County increased from 6.3 percent in 2005 to 11.3 percent in 2009. The second largest contributor is the residential sector, which indicates that home energy use is also a significant factor. The increase in emissions from residential energy use between 2005 and 2009 is largely attributable to the higher emissions factor of the electrical power supplied by Pacific Gas & Electric (PG&E) in 2009. The emissions factor reflects GHG emissions resulting from generation of electricity delivered by PG&E. A higher emissions factor indicates a power mix (coal, natural gas, nuclear, renewables) with a higher percentage of fossil fuel sources. Even though the emissions factor can have a dramatic effect on the County inventory, it is solely controlled by PG&E.

Lastly, the 28 percent decrease in emissions from the solid waste sector reflects less waste generation, greater waste diversion, decomposition of existing waste, and continued operation of an efficient landfill gas collection system that currently captures 85 percent of landfill gas produced.

Table 2-2: Community Emissions by Sector			
Sector	Metric Tons CO_2e Emitted		Percent Change from 2005 Baseline
	Year 2005	Year 2009	
Transportation	555,458	481,787	-13%
Residential	173,336	189,658	9%
Commercial and Industrial	1,158,119	101,588(1)	-91%(2)
Solid Waste	20,124	18,245	-9%
Total	**1,907,037**	**791,278**	**-59%**

Notes:

(1) This much lower number reflects the cessation of manufacturing at the Davenport cement plant. See emissions inventories in Appendix G.

(2) A complete explanation of the change in the commercial/industrial sector is hampered by an inability to completely subtract the contribution from the cement plant from the 2005 inventory. Almost all of the emissions from the cement plant consisted of stack emissions, with a portion of emissions resulting from electricity use (conveyor belt, etc.), which appears to have been a large amount of electricity relative to other electricity use in this sector. While stack emissions are known and can be eliminated, electricity data in this sector is not detailed enough to effectively eliminate use attributable to the cement plant. However, based on known economic conditions it is assumed that this sector as a whole, not counting the cement plant, still experienced some emission reduction between 2005 and 2009, probably due to the economic downturn.

Source: County of Santa Cruz, 2012.

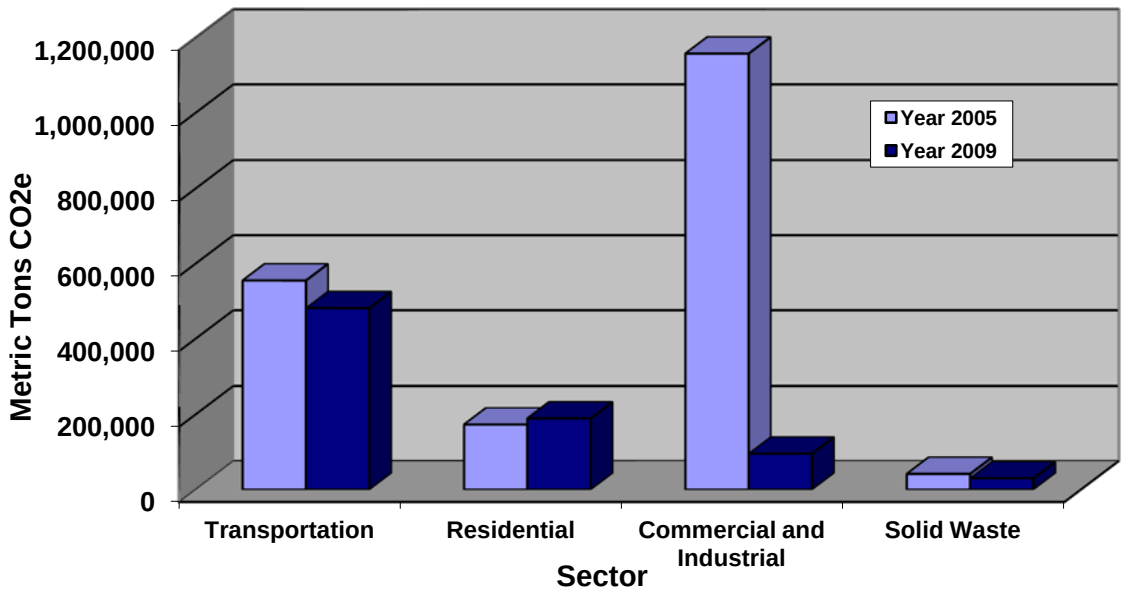

Figure 2-2: Community Emissions by Sector

Source: County of Santa Cruz, 2012.

2.3 Forestry and Agriculture

2.3.1 Forestry

According to the State "Climate Change Scoping Plan" (California Air Resources Board, 2008) California's forests remove approximately 5 million net metric tons of CO_2e from the atmosphere annually. This occurs because there is more CO_2 removed from the air by tree growth than there is emitted by wildfires, wood combustion, wood decomposition, land conversion and other forestry related emissions. This sequestration, or "carbon sink", is a valuable ecosystem service provided by forests. The143,000 acres of redwood and redwood-Douglas fir forests and 19,900 acres of oak woodland in Santa Cruz County (Mackenzie, A., J. McGraw, and M. Freeman, 2011) contribute to this service. Forest lands in the County currently store around 56 million metric tons CO_2e (Mader, Steve, 2007). . State-wide, carbon sequestration by forests is supported by sustainable management practices administered by California's Board of Forestry and Fire Protection as well as initiatives of other state agencies to conserve biodiversity, provide recreation, and promote sustainable forest management. Santa Cruz County is well positioned in terms of local forest practice, rural development policies that conserve timber, and conservation efforts to maintain the carbon sequestration benefits of forest lands in the County. About one quarter of county land area, or about 77,000 acres, is in conservation status and 71,000 acres are reserved timberlands (Mackenzie, A., J. McGraw, and M. Freeman, 2011).

The urban forest provides a diverse array of benefits to human communities. It produces oxygen and removes carbon dioxide, gaseous pollutants, and particulate matter from the air. In addition to improving air and water quality, community trees provide numerous social and economic benefits by providing shade and reducing wind speed. Trees adjacent to buildings reduce air conditioning and heating costs. Urban trees may also reduce the incidence and severity of respiratory disease, asthma, low-level ozone respiratory ailments, and heat-related illnesses (Maas, J., Verheij, R.A., Groenewegen, P.P., de Vries, S., and Spreeuwenberg, P., 2006). Access to parks and green spaces encourages outdoor activity, which can lead to weight loss and reduced health problems associated with obesity. Although urban trees do not sequester nearly as much carbon as our "rural" and mountain forests (McPherson, E. Gregory, Nowak, David J. Rowntree, Rowan A,, 1994) they provide a plethora of major co-benefits. Preserving and encouraging more urban trees during the development permit process is important, and a related action has been included in Strategy E-4.

2.3.2 Agriculture

Santa Cruz County ranks in the top third of California counties for agricultural production. Working farmland, timberland, and rangelands generate over $491 million in annual revenues and employ 8,000 people. Santa Cruz County has some of the most productive cultivated farmland in the state, thanks to a mild Mediterranean climate, exceptionally fertile soil, and consumer demand for high-value crops like berries. The agricultural sector, not including timberland, occupies 8.5 percent of Santa Cruz's land area, or 24,324 acres, and is one of the highest revenue sectors. Figure 2-3 provides crop type in acres for the entire county with the exception of timberland for 2011.

Emissions from agricultural activities come from electricity use for water pumps, fuel for equipment, and excess nitrogen from fertilizer. Electricity use for pumps is already included in the commercial/industrial sector of the community inventory because the PG&E data is aggregated and does not separate out agricultural electricity and natural gas use. Data on agricultural fuel and fertilizer use is not available in a format that can be used in an emissions inventory. Because of a lack of available data there is no baseline or tracking mechanism for total agricultural emissions at this time. For these reason agricultural emissions are addressed separately from the community emissions inventory. However, by using information from published crop reports and studies, rough estimates of emissions from agricultural fuel and fertilizer use have been calculated for many crops, as shown in Table 2-3. These results should only be used for rough comparison to the overall community emissions.

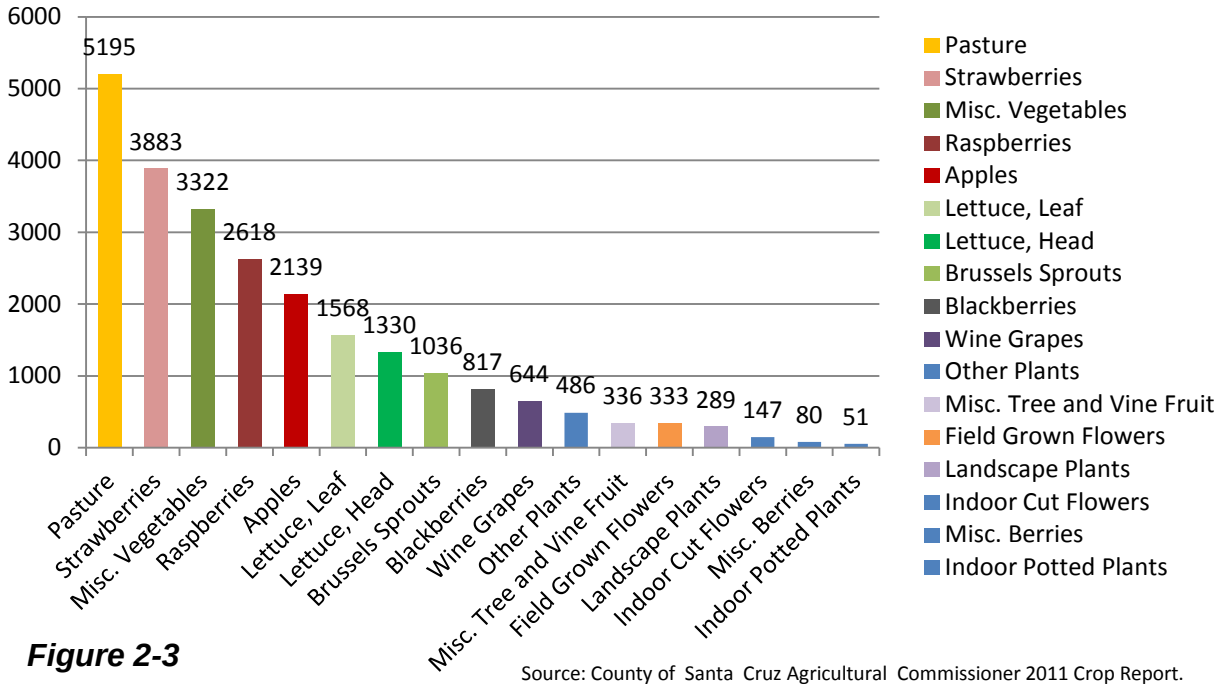

Figure 2-3

Source: County of Santa Cruz Agricultural Commissioner 2011 Crop Report.

Table 2-3: Crop Emissions by Crop Type (in Mt CO_2e/yr)

Crop Category	2005	2009	Percent Change from 2005 Baseline
Pasture	744	703	-6%
Strawberries	4,785	4,576	-5%
Misc. Vegetables	4,007	4,388	8%
Raspberries	657	600	-10%
Apples	1,606	1,388	-16%
Lettuce, Leaf	3,696	1,813	-104%
Lettuce, Head	3,417	1,777	-92%
Brussels Sprouts	1,217	1,145	-6%
Wine Grapes	204	223	8%
Misc. Tree and Vine Fruit	124	177	30%
Total	20,456(1)	16,791(1)	-21%(2)

Notes:

(1) This number does not account for field grown flowers, landscape plants, indoor cut flowers, miscellaneous berries, indoor potted plants, wild hay, and other plants. These unmeasured categories occupy 1,972 acres in 2005 and 1,976 acres in 2009, or approximately eight percent of total cropland. They were not included in the emissions inventory due to insufficient data.

(2) It is important to note that these changes reflect changes in crop patterns, not necessarily changes in practices that have reduced or increased emissions. Though there may have been changes in practices, data does not yet exist for that.

Source: County of Santa Cruz, 2012.

Emissions from agricultural fuel and fertilizer use account for at most two percent of County CO_2e emissions, or approximately 17,000 metric tons. In addition to its relatively low emissions profile, agriculture has the potential to sequester carbon from the air and store it in the soil, and the maintenance of lands for agriculture prevents those lands from being used for far more carbon intensive urban development.

The emissions that do exist from farming, however, can be reduced, and carbon sequestration potential can be enhanced by increasing low or no till practices, using more fuel efficient farm equipment and pumps, eliminating methyl bromide, and reducing surplus nitrogen when fertilizing crops.

Currently, growers are implementing practices to conserve water and are constantly searching for ways to reduce nitrogen usage without reducing crop yields. Higher efficiency farm equipment and pumps are also sought (when funding is available). All of these measures reduce costs for growers while reducing greenhouse gas emissions. The County can play a role by assisting these efforts, encouraging the adoption of lower emission farming practices such as reduced tillage and low input farming, and by encouraging growers and processors to take advantage of the Property Assessed Clean Energy (PACE) program. PACE provides 100 percent financing to commercial and agricultural property owners who increase energy efficiency, with repayment to be repaid through property tax assessments and other favorable terms.

2.4 The "Business as Usual" Forecast

Preparatory to discussion of the CAS specific emissions reductions targets, it is useful to prepare a "business as usual" scenario (BAU) to estimate future emissions. Emissions from agricultural fuel and fertilizer use are not included in the forecast. The BAU forecast assumes no new actions are taken to reduce emissions and the economy grows according to regional projections that assume the economic downturn does not continue to 2020 and beyond. Inherent difficulties in predicting the future notwithstanding, the BAU forecast is a helpful tool that indicates how much reduction must be accomplished in order to reach any given level of emissions by 2020, 2035 or 2050.

The BAU forecast uses data from AMBAG's 2008 Regional Forecast for population, housing units, and employment, and the Metropolitan Transportation Plan 2008 Supplemental EIR, which estimates future trends in the VMT out to 2035. Trends in housing units and employment can be used to forecast emissions in the residential and commercial/industrial sectors, respectively, and trends in VMT can be used to forecast emissions in the transportation sector.

The BAU forecast (Table 2-4 and Figure 2-4) shows that emissions in 2035 will be 11 percent higher than they were in 2009. This indicates that the emissions reduction strategies in the CAS must be implemented very effectively, as they will be relied upon not only to decrease emissions from current County activities, but to reverse an upward trend. However, the BAU forecast also represents a worst case scenario in that it assumes no mitigation actions to reduce GHG emissions are taken, when in fact actions are already being taken at the state and local level. Three state-wide initiatives that require no local action and which may lead to significant emissions reduction in our community are the Clean Car Standards (Pavely I and II), Low Carbon Fuel Standard, and the Renewable Portfolio Standard known as RPS (California Air Resources Board, 2008). The first two will reduce emissions associated with VMT by reducing the carbon content of fuel and improving fuel efficiency of the fleet. The third will reduce emissions from home and commercial energy use by lowering emissions associated with producing the energy.

The emissions reductions from these programs, as estimated by the California Air Resources Board in the Scoping Plan (California Air Resources Board, 2008) and by various cities and counties in their climate action plans, may reduce 2035 emissions to below 2009 levels. If that occurs, the state initiatives will have accomplished approximately 68 percent of the reduction that is required to meet the Santa Cruz County 2035 and 2050 targets. This does not, however, indicate that the actions in the County of Santa Cruz CAS do not need to be implemented; rather, it indicates that a greater or lesser effort may be required as the context of state regulations and programs evolves, and that the CAS must be flexible, with adjustments made when necessary.

Table 2-4: Community Emissions Growth Projections by Sector				
	Inventory Years		Forecast from 2009 data	
Sector	2005	2009	2020	2035
Transportation	555,458	481,787	500,664	527,603
Residential	173,336	189,658	197,089	207,694
Commercial / Industrial	1,158,119	101,588[(1)]	110,652	124,330
Solid Waste	20,124	18,245	18,671	19,268
Total	**1,907,037**	**791,278**	**827,076**	**878,894**

Note:
(1) Figure no longer includes emissions from the Davenport cement plant due to cessation of manufacturing activity.
Source: County of Santa Cruz, 2012.

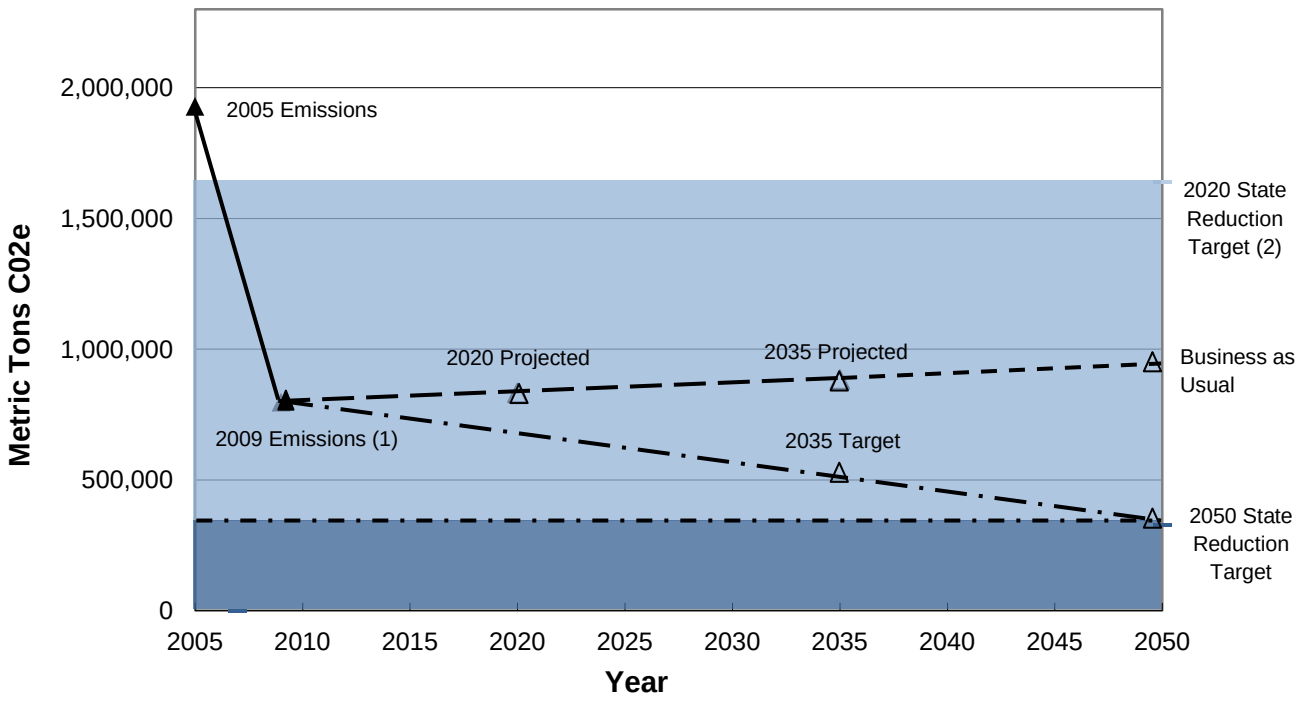

Figure 2-4: Business as Usual Growth Projections and Statewide Reduction Targets

Notes:

(1) The forecast is based on the 2009 inventory year, and not the trend between 2005 and 2009, because of unique circumstances related to the cement plant closing, and the significant downturn in the economy that occurred between 2005 and 2009.

(2) The *Climate Change Scoping Plan* (2008) prepared by the California Air Resources Board to implement the California Global Warming Solutions Act of 2006 (AB 32) recognizes that most local communities will use 2005 as their baseline year for evaluation of greenhouse gas emissions, and provides that a goal of 15% below 2005 levels is considered roughly equivalent to reducing emissions to 1990 levels by 2020, which is the goal established by AB 32.

Source: County of Santa Cruz, 2012.

2.5 Emissions Reduction Targets for 2020, 2035 and 2050

The state has set reductions targets for 2020 and 2050 (California Air Resources Board, 2008)[3]. Local governments are encouraged to adopt parallel goals. As shown in Table 2-4 and the Figure 2-4, in unincorporated Santa Cruz County the state's goal for 2020 has already been met as a result of cessation of manufacturing at the Davenport cement plant. Given that circumstance, it is useful to set an intermediate target in order to have a milestone to work toward on the way to 2050. The year 2035 was chosen as an appropriate intermediate year, because it is the planning horizon for the Regional Sustainable Communities Plan being prepared by the Association of Monterey Bay Governments (AMBAG), the AMBAG housing and employment forecast, the Metropolitan Transportation Plan, and the Regional Transportation Plan.

The lower line on the graph in Figure 2-4 shows the slope of a straight line between County emissions in 2009 and what emissions must be in 2050 if the 2050 target is to be met. Points along the line are milestones that must be achieved to remain on a constant path toward the 2050 goal. In 2035, in order to be on track, emissions must be reduced by 300,000 metric tons, which is a reduction of 38 percent below 2009. This is an appropriate mid-term target and the reduction strategies in the next section have been assembled with it and the 2050 target in mind. Table 2-5 is a summary of the GHG emissions reduction targets.

Table 2-5:
Summary of GHG Emissions Reduction Targets

Reduction	Target Years		
	2020	2035	2050
Reduction below 2009 (metric tons CO_2e)	140,000	300,000	470,000
Percentage reduction relative to 2009 emissions	18%	38%	59%
Reduction below "Business as Usual" projections	170,000	380,000	590,000
Percentage reduction relative to "Business As Usual" projections	21%	43%	64%

Source: County of Santa Cruz, 2012.

[3] The 2020 target consists of a reduction to 1990 levels, which equates to a 15% reduction below 2005. The 2050 target consists of an 80 percent reduction below 1990 levels.

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3.0 Proposed Greenhouse Gas Emissions Reduction Strategies

Achieving the substantial emissions reductions required to meet the targets for 2035 and 2050 will require considerable effort by both government agencies and the community over the next several decades.

3.1 Government Leadership

Santa Cruz County government has a long history of policies and actions that have directly and indirectly resulted in emissions reductions (see Appendix A). Building on this foundation the County can provide leadership and set an example of what can be accomplished by large organizations and the community as a whole.

With over 2,200 employees in 2009 and a wide range of responsibilities carried out by numerous departments, achieving emissions reductions in County government requires activities on a number of fronts. Coordination of these efforts requires representatives of every department to participate in strategy development, implementation, and monitoring. The emissions reductions strategies in the CAS have been developed with assistance from a number of County departments, and this coordination should continue with the establishment of a formal mechanism for each County Department to identify and report to the Board to Supervisors on the strategies that are implemented each year, or within another specified reporting period.

3.2 About the Emissions Reduction Strategies

The results of the emissions inventories indicate that GHG reduction strategies should focus on three areas: Transportation, Energy, and Solid Waste. Strategies to reduce emissions are presented in the tables below, organized by focus area. A series of implementing actions is listed for each strategy. Criteria used to select strategies include the amount of emissions reduction that might be achieved, estimated cost, feasibility, state laws, guidelines and recommendations, and potential for community benefits beyond GHG reduction ("co-benefits").

3.3 Overall Potential for Emission Reduction

The strategies that follow have the potential to reduce GHG emissions by an amount that would meet 2035 and 2050 goals for the County of Santa Cruz. Actual emissions reductions will depend on the combination of the implementing actions that is pursued and the amount of effort and resources that are dedicated to the challenge. Chapter 4 covers implementation in detail.

3.4 Energy Strategies

Use of electricity and natural gas in the residential and commercial sectors accounted for almost 37 percent of the total community emissions in 2009. Emissions in the energy sector were estimated using energy use data and emissions factors provided by PG&E. The inventory includes electricity and natural gas use throughout the utility service area in the County, but does not include emissions from propane use in rural areas of the County.

Emissions from the energy sector can be reduced by focusing on energy efficiency in existing and new buildings, small and large scale renewable energy development, and increasing local control over energy procurement for the community. State initiatives such as the Renewable Portfolio Standard (RPS), California Solar Initiative (California Air Resources Board, 2008) and building and energy efficiency codes, will accomplish significant emissions reductions through efficiency and renewable energy development. The CAS can therefore focus on

local opportunities that encourage and build on these initiatives through encouraging local renewable energy, local building codes, and financing mechanisms.

Local control over energy procurement for the community is enabled by state law allowing communities to form Community Choice Aggregation (CCA) programs. CCA works by pooling the community's demand for energy and creating an option for local control of the process of buying energy. CCA agencies purchase power, set rates, and operate a variety of targeted conservation programs, while PG&E continues to be responsible for the transmission system. When there is an alternative to PG&E, the community can choose to buy a higher percentage of renewable power, set the rates that are paid to owners of small commercial and residential solar energy systems, develop shared, local renewable power supplies, operate a transparent process for setting rates, increase reliability by managing peak demand, and address all types of energy-related consumer issues at the local level. Because any residential, businesses and/or industrial consumer can participate in CCA, and the CCA functions on so many levels to buy, produce, and encourage renewable energy and conservation, it is a powerful tool to reduce carbon emissions across all sectors. It is particularly attractive that CCA targets emissions not only in the energy use sector, but also the very challenging transportation sector, by providing a cleaner source of electricity to fuel electric vehicles.

Strategies to reduce emissions in the energy sector could lead to a number of additional community benefits including clean air, less expensive energy, green jobs, a stronger local economy, and energy independence.

Table 3-1: Strategies for the Reduction of Greenhouse Gases from Energy Use

Priority	Strategy
E-1	Develop a Community Choice Aggregation (CCA) Program, if feasible
E-2	Increase energy efficiency in new and existing buildings and facilities
E-3	Enhance and expand the Green Business Program
E-4	Increase local renewable energy generation
E-5	Public education about climate change and impacts of individual actions
E-6	Continue to improve the Green Building Program by exceeding the minimum standards of the state green building code (Cal Green)
E-7	Form partnerships and cooperative agreements among local governments, educational institutions, non-governmental organizations, and private businesses as a cost-effective way to facilitate mitigation and adaptation
E-8	Reduce energy use for water supply through water conservation strategies

Strategy E-1: Develop a Community Choice Aggregation (CCA) Program			
	Action	**Responsibility**	**Performance Indicator**
E-1.1	Seek funding to perform a study of the feasibility of Community Choice Aggregation.	County and Stakeholders	• Feasibility Report
E-1.2	Form a steering committee composed of the County, cities, water districts, waste management districts, and other stakeholders to provide input and guide the CCA feasibility study.	County and Stakeholders	• Steering Committee
E-1.3	Form a Joint Powers Authority (JPA) composed of the County with partner cities and special districts in order to consider actions necessary to implement a CCA program, if a CCA is determined to be feasible.	County and Partner Agencies	• JPA

Strategy E-2: Increase energy efficiency in new and existing buildings and facilities			
	Action	**Responsibility**	**Performance Indicator**
E-2.1	Promote Energy Upgrade California (EUC) and successor programs (ongoing).	Planning, General Services	• EUC data
E-2.2	Consider extending the Green Business Program model to the residential sector. Include an awards program.	Public Works, General Services, Environmental Health	• Program participation rate
E-2.3	Continue membership as a Phase 1 community in the California Communities commercial PACE program to finance solar energy projects on commercial properties and assist with marketing this bond- funded, financing assistance program to local businesses of all sizes (ongoing).	Planning, Treasurer/Tax Collector, General Services	• Number of financing packages completed and installed capacity of renewable energy
E-2.4	Support state proposals for disclosure regarding use of energy in existing buildings, AB 1103 and AB 531.	Planning, CAO	• "Benchmark" statistics become available
E-2.5	Consider time-of-sale energy efficiency program that encourages energy retrofit, supplies information about energy use and conservation opportunities. May be used to implement state energy "benchmarking" policies.	Planning, General Services, Community Organizations	• Number of transactions that include energy efficiency
E-2.6	Incentivize participation in the Green Business Program and use of the emissions calculator.	Public Works	• Participation rate
E-2.7	Continue the program of upgrading lighting (LEDs), heating and cooling systems, appliances, equipment and control systems by seeking funding sources to complete projects at County facilities (ongoing).	General Services, Public Works	• Projects completed
E-2.8	Continue the Green Government Certification program for County facilities, and enhance the program by expanding it to all County facilities and improving the standards for recertification (ongoing).	Public Works, All County Departments	• Recertification and enhanced standards
E-2.9	Amend County street lighting standards to require LED streetlights as feasible, in coordination with PG&E.	Public Works	• Amended standards
E-2.10	Consider defining categories of development projects that release greenhouse gas emissions below the Monterey Bay Unified Air Pollution Control District adopted thresholds, and for which analysis using the CalEEMod Model is not required to characterize emissions.	Planning	• Categories established

Strategy E-3: Enhance and expand the Green Business Program			
	Action	**Responsibility**	**Performance Indicator**
E-3.1	Consider additional capacity to expand the Green Business Program in Santa Cruz County with additional staff resources, and through the use of the County website.	Public Works	• Staffing Green Business Program • Web site updated
E-3.2	Create and promote a program similar to the Green Business Program, for use by individual residents, households, and neighborhoods.	Planning, Public Works	• Number of Participants

Strategy E-3: Enhance and expand the Green Business Program			
	Action	**Responsibility**	**Performance Indicator**
E-3.3	Consider enhancing the Green Business awards program to recognize and rate exceptional achievements.	Public Works	• Number of awards
E-3.4	Continue to enhance standards for Green Business certification and recertification to foster increasing levels of achievement (ongoing). Consider enhancing the Green Business checklist to incorporate benchmarks related to vehicles miles traveled per employee.	Public Works	• Enhanced standards

Strategy E-4: Increase local renewable energy generation			
	Action	**Responsibility**	**Performance Indicator**
E-4.1	Seek funding for a study to identify renewable energy resources in the County and advise on how the amount of renewable energy generated within the County may be increased over short-, medium-, and long-term.	Planning, General Services	• Study progress
E-4.2	Promote neighborhood and industry equipment and services "group buy" programs by facilitating contacts among groups of neighbors or businesses and solar energy system contractors and financing entities.	Planning, Community Organizations	• Installed capacity of renewable energy
E-4.3	Review ordinances for opportunities to remove barriers to the installation of renewable energy projects. Use the California State Association of Counties (CSAC) model solar ordinance as a resource.	Planning	• Amended ordinances
E-4.4	Identify areas that contain renewable energy resources such as wind and solar.	Planning	• Zoning overlays
E-4.5	Review and strengthen solar access ordinance to ensure protection of solar resources; consider incentives and exceptions.	Planning	• Amended ordinance
E-4.6	Review County ordinances to identify potential barriers that may exist to the installation of solar thermal and photovoltaic systems.	Planning	• Amended ordinance
E-4.7	Consider amending the Zoning Ordinance to require or incentivize new parking lots to be covered with structures that support solar production facilities, where feasible. Encourage similar installations on existing parking lots.	Planning	• Installed capacity
E-4.8	Review ordinances and design guidelines for opportunities to ensure roof orientation and other measures such as strategic tree planting to reflect active and passive solar energy principles.	Planning	• Amended ordinances
E-4.9	Support the Santa Cruz County solar energy project to install photovoltaic panels and associated equipment at the former Ben Lomond landfill.	Public Works	• Installed generation capacity
E-4.10	Increase renewable energy generation on other County facilities, as feasible (ongoing).	General Services	• Installed capacity

Strategy E-5: Public education about climate change and individual actions			
	Action	**Responsibility**	**Performance Indicator**
E-5.1	Promote climate change education programs in local schools by maintaining energy conservation curriculum in the green schools program.	Public Works	• Participating schools • Contracts with local non-profit organizations
E-5.2	Create a Climate Action web site with access to tools for calculating and tracking energy use, emissions, and carbon footprint, and information to promote low carbon lifestyles, including information about rebates and other available incentives.	Planning, Information Services	• Web application, number of visitors
E-5.3	Promote home energy audits and commercial benchmarking to help building owners target appropriate energy efficiency and renewable energy projects.	Planning	• Program data as available

Strategy E-6: Continue to improve the Green Building Program by exceeding the minimum standards of the state green building code (Cal Green)			
	Action	**Responsibility**	**Performance Indicator**
E-6.1	During each code adoption cycle consider exceeding Cal Green mandatory measures by adopting all or some elements of Cal Green Tier 1 and 2 voluntary elective measures to increase energy efficiency in new buildings, remodels and additions. Specifically consider requiring solar generation facilities on new buildings and pre-wiring of buildings to accommodate photovoltaics and electric vehicle charging. Consider local amendments to remove code obstacles to the use of photovoltaic systems.	Planning	• Updated building code
E-6.2	Establish green building awards program.	Planning	• Number of awards
E-6.3	Research incentives for achieving a higher level of green building than required by current code standards.	Planning	• Establishment of incentives

Strategy E-7: Participate in collective action and cooperative agreements among local governments, educational institutions, non-governmental organizations, and private businesses as a cost-effective way to facilitate mitigation and adaptation			
	Action	**Responsibility**	**Performance Indicator**
E-7.1	Participate in the Climate Action Compact (CAC) to implement regional energy efficiency and renewable energy programs in partnership with CAC members (ongoing).	Planning	• Program implementation
E-7.2	Form a regional energy authority or other organizational structure to study, promote, develop, conduct, operate, and manage energy and energy-related climate change programs.	Planning, General Services, CAO	• Action progress
E-7.3	Continue to support the efforts of the Workforce Investment Board to promote green jobs and training for green jobs (ongoing).	Human Services Department	• Continued availability of training options for green job related occupations

Strategy E-8: Reduce energy use for water supply through water conservation strategies			
	Action	**Responsibility**	**Performance Indicator**
E-8.1	Consider adoption of water conservation ordinance to update and expand the County's water conservation measures. Explore the possibility of including a water conservation impact fee on new development to mitigate additional water demand and fund conservation programs.	Environmental Health Services	• New ordinance
E-8.2	Adopt a water efficient landscape ordinance (WELO) that meets or exceeds the standards of the state model ordinance	Planning	• New ordinance
E-8.3	To reduce demand for potable water, promote the use of residential greywater irrigation in a manner that is protective of public health and safety and the environment. Work with the Greywater Alliance to establish procedures and to conduct trainings (ongoing).	Planning, Environmental Health Services	• Systems installed

3.5 Transportation and Land Use Strategies

The transportation sector accounts for almost 60 percent of the total 2009 GHG emissions produced in Santa Cruz County. Emissions in the transportation sector were estimated using published data on VMT on local roads and state highways in the unincorporated area of the County, corrected to account for fuel efficiency variations among classes of vehicles. Reducing emissions from VMT is a high priority, which can be approached either by reducing the number of miles traveled, using various land use, economic development, alternative transportation and public outreach strategies; or by reducing the impact of the miles traveled, by increasing fuel efficiency in the fleet, reducing the carbon content of fuel, or increasing traffic efficiency.

Alternative transportation to reduce VMT can be encouraged in many ways. Local land use strategies can encourage compact and mixed use development that supports transportation modes such as biking, walking, transit and carpooling. Employee commutes can be influenced by economic development strategies that create local employment opportunities and provide affordable housing so employees can reside locally.

State initiatives such as the Clean Car Standards and Low Carbon Fuel Standards will reduce emissions through increased fuel efficiency and lower fuel carbon content. The CAS can therefore focus on local opportunities, such as developing the infrastructure needed to accommodate the expected increase in plug-in electric, hybrid, and fuel cell vehicles and obtaining access to cleaner electricity to fuel them.

Strategies to reduce emissions in the transportation sector lead to a number of associated community benefits including improved mobility, a stronger economy, monetary savings, improved air quality, improved public health, and social equity.

Table 3-2: Strategies for the Reduction of Greenhouse Gases from Transportation	
Priority	**Strategy**
T-1	Reduce vehicle miles traveled (VMT) through County and regional long range planning efforts
T-2	Increase bicycle ridership and walking through incentive programs and investment in bicycle and pedestrian infrastructure and safety programs
T-3	Provide infrastructure to support zero and low emissions vehicles (plug in, hybrid plug-in vehicles)
T-4	Increase employee use of alternative commute modes: bus transit, walking, bicycling, carpooling, etc.
T-5	Reduce County fleet emissions

Strategy T-1: Reduce vehicle miles traveled (VMT) through County and regional long range planning efforts			
	Action	**Responsibility**	**Performance Indicator**
T-1.1	Support the viability of rail transit through land use planning using a range of transportation, housing and commercial land use strategies.	Planning	• Specific planning initiatives
T-1.2	Study and consider adjusting transportation and roadside impact fees to promote multimodal transportation infrastructure improvements.	Planning, Public Works	• Updated fee structure
T-1.3	Complete the Santa Cruz County Sustainable Communities and Transit Corridor Plan (underway).	Planning	• Plan is adopted
T-1.4	Participate in Regional planning efforts, including the Regional Traffic Model Improvement Plan, Regional Sustainable Communities Plan, Regional Transportation Plan, and the Regional Housing Needs Assessment, with a focus on climate action goals and emission reduction (ongoing).	Planning, Public Works	• Participation
T-1.5	Develop mixed use and infill ordinances that incorporate sustainable communities concepts.	Planning	• Ordinance adoption
T-1.6	Develop a reuse plan for the Davenport cement plant property that incorporates public transit, pedestrian and bicycle access, and renewable energy elements.	Planning, Property Owner	• Reuse plan
T-1.7	Prepare a County Economic Vitality Strategy and promote economic development activities that create local jobs to reduce employee commute trips out of the County (ongoing).	Planning, Workforce Investment Board	• Economic vitality and development initiatives; improved jobs/housing balance
T-1.8	Promote the development of affordable housing to reduce employee commute trips from surrounding counties into Santa Cruz County (ongoing).	Planning, Developer	• New and retained affordable housing; improved jobs: housing balance
T-1.9	Incorporate complete streets concepts into the Zoning Ordinance and into developments (ongoing).	Planning, Public Works	• Ordinance amended as necessary; Projects incorporate complete streets design concepts
T-1.10	Ensure that development projects contain measures that enhance multi-modal transportation options (ongoing).	Planning, Developers	• Approved site and building plans include these measures
T-1.11	Review site design criteria in the Zoning Ordinance for opportunities to emphasize pedestrian and bicycle amenities and connections between and among neighborhoods, commercial areas, schools and recreation sites.	Planning, Public Works	• Zoning Ordinance is revised as necessary
T-1.12	Consider unbundling parking costs as part of Transportation Demand Management programs (i.e. require that parking is paid for separately and is not included in rent for residential and commercial space).	Planning, Developers and Property Managers	• Planning policies include this TDM tool
T-1.13	Implement the policies of the Sustainable Community and Transportation Corridor Plan when it is completed.	Planning, Developers, RTC, SC Metro	• Ordinance and General Plan Amendments completed; Development projects implement policies

Strategy T-1: Reduce vehicle miles traveled (VMT) through County and regional long range planning efforts			
	Action	**Responsibility**	**Performance Indicator**
T-1.14	Plan and implement reasonable infrastructure and other improvements (e.g. signal timing) that reduce traffic congestion to maximize fuel efficiency (ongoing).	Public Works, Developers, RTC, SC Metro	• Projects funded and completed

Strategy T-2: Increase bicycle ridership and walking through incentive programs and investment in bicycle and pedestrian infrastructure and safety programs			
	Action	**Responsibility**	**Performance Indicator**
T-2.1	Consider funding an infrastructure network using development fees that is dedicated to bicycle and pedestrian infrastructure.	Planning, Public Works	• Fund is Established
T-2.2	Work with the Santa Cruz County Regional Transportation Commission (RTC) to support and implement the Monterey Bay Sanctuary Scenic Trail project.	Planning, Public Works	• Funding and completion of Monterey Bay Sanctuary Scenic Trail projects
T-2.3	Increase the effectiveness of the County Bicycle Plan by seeking funding to develop bicycle infrastructure prioritized in the Plan.	Planning, Public Works	• Projects funded and completed
T-2.4	Continue to seek opportunities to implement the Safe Routes to School Program locally by seeking grant funding under the Program for applicable projects (ongoing).	Planning Public Works	• Projects funded and completed
T-2.5	Continue to support the Community Traffic Safety Coalition (CTSC) in the Health Services Agency with funding from the RTC (ongoing).	Health Services Agency	• Ongoing CTSC program
T-2.6	Work with the RTC and Public Works to implement the recommendations of the RTC's Safe Paths of Travel report regarding pedestrian travel.	Planning, Public Works	• Projects funded and completed
T-2.7	Review site design criteria in the Zoning Ordinance for opportunities to emphasize pedestrian amenities and connections between and among neighborhoods, commercial areas, schools and recreation sites.	Planning, Public Works	• Zoning Ordinance is revised as necessary
T-2.8	Install and continue to upgrade bike lockers at County facilities.	General Services	• Number of new bicycle lockers
T-2.9	Install and upgrade shower and changing facilities at County facilities.	General Services	• Upgraded facilities
T-2.10	Support loan programs administered by GSD to promote bicycle ridership.	General Services	• Number of loans

Strategy T-3: Provide infrastructure to support zero and low emission vehicles (plug in electric, hybrid plug in vehicles)			
	Action	**Responsibility**	**Performance Indicator**
T-3.1	Consider incentives and requirements to install EV charging stations in parking lots for new development and substantial remodel/addition of existing buildings.	Planning/Building	• Number of charging stations and fuel cell infrastructure
T-3.2	Require pre-wiring of buildings to accommodate electric vehicle charging.	Planning/Building	• Requirements are in the County Code
T-3.3	Support the goals of the Monterey Bay Electric Vehicle Alliance (MBEVA) through pursuit of funding for installation of publicly-available EV charging stations; supportive policies, including streamlined EV charging station permit processing, and increased number of EVs in the county fleet; attracting electric vehicle businesses to the County.	Planning, General Services	• Number of alternative fuel vehicles, charging stations, and fuel cell infrastructure

Strategy T-4: Increase employee use of alternative commute modes.			
	Action	**Responsibility**	**Performance Indicator**
T-4.1	Help raise the community profile of Commute Solutions and other bicycle services provided by the RTC, and CTSC by including a link to their websites on the Climate Action Strategy webpages and on other high profile County of Santa Cruz web pages.	Planning, Public Works	• Links established
T-4.2	Encourage employers to implement voluntary trip reduction measures in the Trip Reduction Ordinance (County Code 5.52) (ongoing), and consider updating the Zoning Ordinance with a new trip reduction-transportation demand management ordinance.	Planning	• Employer participation • Zoning Ordinance is revised as necessary
T-4.3	Continue to provide alternative commute programs for County employees including vanpools, emergency ride home voucher, fleet bikes, bus passes, and bike lockers for County employees who commute to work using alternative modes (ongoing).	General Services Department	• Number of bus passes, Number of van riders
T-4.4	Look for funding sources to fully implement the RideSpring[4] service with incentives for choosing alternative commute modes (ongoing).	General Services Department	• RideSpring statistic on "miles saved" and number participants
T-4.5	Consider the feasibility of additional flexible work hours to support employee use of alternative commute modes.	All County Departments	• Availability of flexible work hours
T-4.6	Continue to provide staff resources in the General Services Department for alternative transportation programs for County employees (ongoing).	General Services Department	• Staffing levels

[4] RideSpring is a web-based database to provide both employers and employees with convenient alternative commute modes.

Strategy T-5: Reduce County fleet emissions			
	Action	**Responsibility**	**Performance Indicator**
T-5.1	Continue to follow through on results of the pilot program (Networkfleet) to improve fleet fuel efficiency through improved vehicle maintenance and fuel efficient driving habits.	General Services, County Employees Who Drive County Vehicles	• Fleet fuel savings
T-5.2	Continue to upgrade the County fleet with strategic purchases of fuel efficient vehicles, including zero and low emission vehicles (ongoing).	General Services	• Fleet vehicle mix, fuel savings
T-5.3	Look for opportunities to expand the use of compressed natural gas (CNG) (ongoing).	General Services	• CNG use
T-5.4	Upgrade the Public Works diesel fleet as required to comply with state and federal mandates for more fuel efficient diesel engines (ongoing).	Public Works, General Services	• Compliance with diesel truck rules
T-5.5	Consider incorporating more biodiesel in diesel vehicles as equipment and state law permits.	Public Works, General Services	• Biodiesel use

3.6 Solid Waste Strategies

As solid waste decomposes in the landfill it produces methane gas, a powerful GHG. Emissions from solid waste can be reduced by collecting and recycling as much of the methane as can be captured with current technology (which is on the order of 75-95 percent), but it is a superior strategy to reduce waste in the first place by limiting use of material that cannot be recycled and which generates waste. The current average capture rate for the Buena Vista Landfill is 85 percent.

The emissions level in the inventory is the estimated amount of methane that bypasses the gas collection systems at the landfills. The landfills in Santa Cruz County are well-controlled by the existing collection systems and a relatively small percentage of methane escapes. The landfill gas that is collected at the Buena Vista landfill is burned in engine generators that produce electricity that is connected to the electric grid.

Regarding reducing waste in the first place, the Public Works Department is a leader in the state in terms of waste diversion and recycling efforts, including construction and demolition waste diversion, composting, and “take back” programs for medicines and sharps, fluorescent lamps, and household hazardous waste. In addition, Public Works funds or participates in education programs in the community covering various topics including recycling and waste reduction. Further efforts to reduce waste have included the adoption of several ordinances, to include a bag ordinance that restricts the distribution of single-use plastic carry-out shopping bags and charges a fee for paper carry-out shopping bags, a polystyrene ordinance that restricts the distribution of polystyrene by retail food establishments and vendors, and an electronic waste ordinance. Anticipated future planning for a Zero-Waste Eco-Park responds to the fact that the Buena Vista landfill is reaching capacity and even more aggressive waste reduction and recycling, including pursuing feasible “waste-to-energy” technologies, would be desirable.

Although further emissions reductions in the solid waste sector are certainly possible, and will be achieved through the ongoing efforts of Public Works and the community, the effect of that strategy on the overall emissions inventory is expected to be rather minimal because of the relatively small percentage of the overall emissions that is produced by municipal solid waste.

Table 3-3: Strategies for the Reduction of Greenhouse Gases from Solid Waste

Priority	Strategy
W-1	Pursue "waste to energy" capacity at County landfill through acquiring existing capacity and investigating new technology
W-2	Improve existing landfill gas capture system to increase percentage capture of landfill gases
W-3	Reduce the amount of solid waste, particularly recyclable and compostable materials, in the commercial and residential waste stream

Strategy W-1:
Pursue "waste to energy" capacity at County landfill through improving existing capacity and investigating new technology

	Action	Responsibility	Performance Indicator
W-1.1	Pursue installation of "waste-to-energy" technology that meets environmental standards, and supports and enhances recycling efforts.	Public Works	Technology evaluated
W-1.2	Utilize the electric power produced by landfill gas at the Buena Vista landfill for the County of Santa Cruz instead of the current scenario in which the electricity production is purchased by other jurisdictions.	Public Works	Determine likely remaining lifetime of landfill gas energy generation capacity and evaluate best strategies for generating energy during this period

Strategy W-2:
Improve existing landfill gas capture system to increase percentage capture of landfill gases

	Action	Responsibility	Performance Indicator
W-2.1	Seek funding for design and installation of improved landfill gas capture system at Buena Vista Landfill.	Public Works	Project funded
W-2.2	Install system improvements by 2020.	Public Works	System upgraded

Strategy W-3:
Reduce the amount of solid waste, and recyclable and compostable materials in the commercial and residential waste stream

	Action	Responsibility	Performance Indicator
W-3.1	Continue planning for implementation of a Zero Waste Eco Park to meet the County's long term zero waste goal (ongoing).	Public Works, Planning	• Project status
W-3.2	Continue to advocate for Extended Producer Responsibility (EPR) through membership in the California Product Stewardship council and other actions that encourage and achieve EPR (ongoing).	Public Works	• EPR in state law
W-3.3	Continue to partner with and support other local and regional waste reduction programs, and consider enhancements that would further the zero waste goals of the County (ongoing).	Public Works	• Program status and statistics

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4.0 Implementation of Emissions Reduction Strategies

4.1 Calculating the Emissions Reductions Potential of the Strategies

Emissions reduction strategies were evaluated to determine the amount of reduction that can be expected to be realized from each one by applying a software tool developed by the Statewide Energy Efficiency Collaborative, called the "Climate Action Planning Assistant" or "CAPA." The Association of Monterey Bay Area Governments (AMBAG) Energy Watch staff assisted Planning Department staff with the CAPA tool, and provided data on emissions reductions from implementation of energy efficiency programs. Applying the CAPA tool to the County's Climate Action Strategy framework involved using the standard calculation methods, however, in some cases calculations were modified based on available data. Several strategies were not included in the calculations due to insufficient data and low reduction potential, but this is not expected to significantly affect the overall calculations. The calculations, including sources of information, are detailed in Appendix D and summarized in Table 4-1.

Because the feasibility of a community choice aggregation (CCA) program has not yet been assessed the table presents two different scenarios for the future. One scenario has a CCA program in place and the other scenario is run without a CCA program. Both the CCA program and the California Renewable Portfolio Standard (RPS) program involve reducing emissions through meeting electricity demand with more carbon-free sources of electricity, however, the assumed level of reduction varies under the two scenarios. Without a CCA program the RPS would account for a certain amount of emissions reduction based on the percentage of renewable sources of electrical energy in PG&E's energy portfolio. With a CCA program that includes a higher percentage of renewable sources than the RPS, greater emissions reductions would be achieved.

It should be noted that for each of these two scenarios, only the emissions reductions due to energy procurement is included in the calculation. Actually, a CCA program would likely involve more than just electricity procurement. Other aspects of a potential CCA program could involve programs to increase installation of renewable energy systems, and energy efficiency and energy conservation in homes and businesses, and associated emissions reductions. A CCA program could also help further reduce emissions in the transportation sector by supplying more carbon-free power for electric vehicle charging. However, because of lack of data, potential emissions reductions from these types of programs associated with a CCA program are not included in the estimate of potential emissions reductions. The scenario with a CCA program assumes a moderate level of participation in the program (50 percent of electricity load). Participation could be higher with a successful program (the CCA program in Marin County currently serves about 75 percent of electricity customers in Marin County). For these reasons the estimate of emissions reductions under a CCA program is considered conservative.

Similar to the "Business as Usual" emissions growth projections, potential emissions reductions from various strategies are calculated for 2035 because many factors in the calculations are derived from forecasts and goals that generally do not extend beyond 2035, such as the population growth forecast, fleet fuel economy forecast, electric vehicle and carpooling growth goals, and emissions reductions as a result of the Clean Car Standards and the Low Carbon Fuel Standard. Accordingly, in Table 4-1 total potential reductions in 2035 are compared to total reductions needed below "Business as Usual" projections for 2035 (Table 2-5). Additional reductions of nearly 200,000 MT CO_2e will be needed in order to meet 2050 reduction targets. Meeting the 2035 target is an appropriate interim goal because continuation of the successful strategies used to meet the 2035 target would help the County meet the 2050 target, and adaptive management will help improving the effectiveness of

strategies over time. In addition, the full benefits of some strategies may accrue beyond 2035, such as significant reductions in vehicle miles traveled as a result of strategic investment in transportation infrastructure and land use planning.

Table 4-1: Summary of Potential Emissions Reduction by 2035 by Strategy[1]

Strategy	With CCA		Without CCA	
	Potential Reduction Amount in 2035 (Metric Tons CO_2e)	Percent of Total Reductions Needed	Potential Reduction Amount in 2035 (Metric Tons CO_2e)	Percent of Total Reductions Needed
Statewide Initiatives				
California Clean Car Standards and Low Carbon Fuel Standards	186,450	49%	186,450	49%
California Renewable Portfolio Standard (RPS)[2]	34,820	9%	69,650	18%
Statewide Initiatives Subtotal	**221,270**	**58%**	**256,100**	**67%**
County Climate Action Strategy				
Energy				
Community Choice Aggregation Program(CCA)[3]	83,320	22%	0	0%
Energy Efficiency	35,430	9%	47,240	12%
Green Business Program	12,290	3%	23,970	6%
Renewable Energy	3,520	1%	15,060	4%
Education	800	<1%	1,200	<1%
Beyond Title 24	160	<1%	160	<1%
Energy Subtotal	**135,520**	**36%**	**87,630**	**23%**
Transportation				
Transportation Infrastructure and Land Use Planning[4]	20,130	5%	20,130	5%
Electric Vehicle Charging	10,590	3%	10,590	3%
Carpooling	3,730	1%	3,730	1%
Transportation Subtotal	**34,450**	**9%**	**34,450**	**9%**
Solid Waste				
Waste to Energy	3,770	1%	3,770	1%
Solid Waste Subtotal	**3,770**	**1%**	**3,770**	**1%**
Climate Action Strategy Subtotal	**173,740**	**46%**	**125,850**	**33%**
Total Potential Reductions in 2035	**395,010**	**104%**	**381,950**	**101%**
Total Reductions Needed in 2035	**380,000**	**100%**	**380,000**	**100%**

Notes:

(1) See Appendix D for details on emissions reductions calculations for each strategy.

(2) The Renewable Portfolio Standard (RPS) requires all of the state's electricity retailers to meet a 33 percent renewable energy target for retail power by 2020. This calculation assumes future regulations would require a 50 percent carbon free portfolio for PG&E power by 2035. The emissions reductions estimates from the RPS for our local area will vary depending on whether or not a CCA program is implemented. Reductions from a CCA program covering half the projected electricity load in 2035 are reported on a separate line. With a CCA program the reduction from the RPS is estimated by applying a 50 percent carbon free portfolio to half of the projected electricity load (PG&E customers) in 2035. Without a CCA program the reduction is estimated by applying the 50 percent carbon free portfolio to the entire projected electricity load in 2035.

(3) Reductions from energy procurement only for a program with a 100 percent carbon free portfolio applied to half the projected electricity load (CCA customers) in 2035.

(4) Research and empirical evidence shows that improvements to transportation infrastructure (transit, bike, pedestrian) and land use planning (mixed use, infill) result in reductions in vehicle miles traveled (VMT) and corresponding reductions in emissions. See Appendix D for details on the model used for this calculation.

Source: County of Santa Cruz, 2013.

Special Note: *Additional reductions will need to occur between 2035 and 2050 to meet the 2050 target. Assuming that 380,000 metric tons of reductions occurs by 2035, then an additional nearly 200,000 metric tons of reductions would be required to meet the 2050 target.*

4.2 Meeting the 2035 Emissions Reduction Target and Prioritizing Strategies and Actions

For each strategy a calculation was performed to estimate the potential emissions reduction as a result of implementing the strategy. The calculations are structured to model the emissions reduction scenario in 2035 as a result of the strategies. The equations in each calculation incorporate data gathered from various sources cited in the calculations and avoid the use of unsupported inputs. The calculations involve projections into the future (to 2035), which carries inherent risk that future conditions will differ due to unforeseen circumstances. However, the calculations represent a model of potential emissions reductions that could result from full implementation of the CAS.

The scenario including implementation of a CCA program presents the results of the calculations, and shows that the 2035 target of a 380,000 MT CO_2e reduction could be achieved as a result of comprehensive implementation of all of the strategies in the CAS. If a CCA program is not feasible or otherwise not able to be implemented, the resulting gap will require greater reductions from other energy strategies in the CAS, and perhaps from additional strategies that will be new programs that have not been created yet. The numbers shown in Table 4-1 under the scenario without a CCA program reflect increasing the effectiveness of energy efficiency, green business, and educational programs by about 50 to 100 percent, and increasing the rate of installation of rooftop solar systems by about 600 percent. This would be very difficult to achieve without harnessing additional financial resources. As noted above, a successful CCA program could provide such resources, however, the County could also seek to provide incentives for energy efficiency and renewable energy programs that are similar to what a CCA would provide using a different structure.

The potential emissions reduction of each strategy was initially calculated without consideration of the overall emissions reduction needed to meet the County's 2035 GHG emission target. Reasonable levels of implementation were selected based on existing information and expected future trends. When the resulting emissions reduction amounts are summed for all strategies the total potential reduction meets the 2035 target. This indicates that full implementation of the strategies and actions listed in Table 4-1 could achieve the desired reductions for 2035; and likely for 2050, as well. However, it will be very challenging to meet both the 2035 and 2050 reduction targets because that will require action across a variety of areas in which the County has varying levels of jurisdictional control.

The largest emissions reductions, nearly 60 percent, will come from implementation of California Clean Car Standards and Low Carbon Fuel Standards, and the RPS reflecting the power of statewide initiatives that affect entire emissions sectors rather than individual actions. The next largest potential contributor to emissions reductions is CCA, which has a large potential, 22 percent of all reductions, but which has not yet been evaluated for feasibility in the local area.

While significant emissions can be achieved through energy efficiency programs (9 percent), almost all of the programs included in the calculations are implemented by agencies or organizations other than the County, such as AMBAG, PG&E, Ecology Action and Central Coast Energy Services (CCES). The calculations assume the continuation of these programs at current levels into the future. An additional strategy included within the calculations under energy efficiency is a time of sale energy efficiency ordinance.

The Green Business Program has achieved significant emissions reductions to date in the commercial sector, and expansion of this program with additional financial and staff resources to build on its demonstrated success has the potential to be a significant component of the County's climate action strategy. With continuation and moderate expansion of the program (10 additional businesses per year), the Green Business Program can play a significant role in achieving the emissions reduction target (3 percent of 2035 reduction target).

The calculation of potential reductions from renewable energy installation assumes continuation of existing annual installation rates in the County. This is estimated to contribute approximately one percent of the 2035 reduction target. This represents a conservative aspect of the reduction calculations considering the CAS includes actions to encourage increased renewable energy installation in the County.

The calculation of potential reductions from public education assumes a certain number of homes and businesses are made more energy efficient through increased knowledge provided by an energy audit. This is estimated to contribute less than one percent of the 2035 reduction target. It should be noted that responsibility and a mechanism for accomplishing such audits would have to be established.

The County could also adopt building code standards that require greater energy efficiency and greater utilization of renewable energy in new and substantially remodeled buildings. Because this strategy works by limiting the amount of increased emissions from new and remodeled buildings, and because of the low level of building permit activity in the county, stricter building code standards would result in relatively minimal emissions reductions (less than one percent of the 2035 reduction target).

In the transportation sector the calculation of potential emissions reductions from transportation and land use strategies reflects the results of the Rapid Fire modeling tool which calculates results based on empirical data and the latest research on the role of land use and transportation systems on automobile travel and emissions. It was developed by Vision California, a project funded by the California High Speed Rail Authority in partnership with the California Strategic Growth Council. The Rapid Fire model calculates VMT by applying assumptions about VMT to population growth based on research and empirical evidence. The model works by comparing two different development patterns: One applies the existing per capita VMT to the projected 2035 population assuming the increased population is accommodated by continuation of automobile-oriented development patterns, and the other applies a reduced per capita VMT to the projected 2035 population assuming the increased population is accommodated with a high percentage of mixed use and infill development. The overall reduction in VMT from a compact and urban development scenario corresponds to a reduction in emissions compared to the business as usual scenario. These estimates were calculated for the urban portion of Santa Cruz County and indicate a potentially significant contribution of approximately five percent to the 2035 reduction target.

Electric vehicles can play a significant role in emissions reductions (three percent of 2035 reduction target) if the future number of EV's on Santa Cruz roads keeps pace with statewide targets for on-road electric vehicles. Carpooling can also play a significant role in emissions reductions (two percent of 2035 reduction target) if goals established in the next Regional Transportation Plan to decrease single occupancy vehicle mode share compared to the baseline condition up to eight percent by 2035 are realized.

In the solid waste sector the calculator estimates the amount of existing electricity emissions that could be offset if the electric power produced by landfill gas at the Buena Vista landfill were credited to the County of Santa Cruz after the conclusion of the current contractual scenario in which the electricity production is purchased by another jurisdiction. This could contribute approximately one percent of the 2035 reduction target.

Lastly, there may be additional opportunities for emissions reductions that were not calculated that have not been identified yet. The proposed strategies include some actions for which reduction estimates have not been made, and new strategies may be identified as the community focus on emissions reduction becomes more established.

For each strategy there are a number of implementing actions which the County can implement on its own, in collaboration with others, or by encouraging and supporting the actions of others. Priority for implementation typically is a function of the potential gain (in this case the estimated potential for emissions reductions) combined with considerations such as cost to implement, probability of reaching full implementation of the strategy, and co-benefits of the strategy. Implementation of the strategies should be prioritized with respect to the order listed in

Table 4-1 with the highest priority given to the strategies listed first in each sector, while also giving consideration to the constraints of staffing and resources with respect to implementing actions.

4.3 Monitoring

For the County to be successful in achieving the adopted emissions reduction targets of 80 percent below 1990 levels by 2050, a practical implementation plan is needed to track and periodically re-evaluate the activities that are being relied upon to reduce greenhouse gas emissions. Implementation will require an ongoing commitment to track which strategies are achieving results, and a willingness to change course when more effective options become available. This style of implementation is referred to as "adaptive management." There will also need to be ongoing engagement with residents, business, educational institutions, community organizations, and partner jurisdictions to ensure that the strategies remain relevant and attractive so that participation will be strong. The strategy tables in Chapter 3 outline implementing actions for each strategy, assignment of responsibility for implementation, and the performance indicators that will be monitored to measure success for each strategy. The measure of overall emissions reduction will be the periodic updating of the GHG emissions inventory.

4.3.1 Performance Indicators

Performance indicators have been identified to measure implementation of each strategy. Performance indicators reflect the expected product of implementing a specific action and provide a way to measure the degree of implementation or effectiveness of each strategy.

In some cases the calculation of reduction potential measures actual performance data, for example, the number and size of new photovoltaic systems installed, and in some cases it measures an indirect parameter, such as the increase in residential density that may be the result of population growth, land use policy, and/or infrastructure improvements. This mix of direct and indirect measuring criteria may make it difficult to closely track progress across all strategy areas. However, future monitoring reports will address these relationships. The clearest performance indicator overall will be the periodic greenhouse gas inventories.

4.3.2 Reporting

Annual reports from implementing agencies will monitor progress from the emissions reduction strategies and actions. The information will be obtained primarily from County departments and to the extent feasible from outside agencies and organizations. The emission inventories and the estimates of emissions reduction will be periodically updated as well. Monitoring reports that correlate this information can evaluate the overall effectiveness of the mitigation portion of the CAS, and may make recommendations to modify the CAS for greater effectiveness.

4.3.3 Five Year Emissions Inventories Updates

A schedule for follow up activity ensures that the plan doesn't just sit on the shelf. Monitoring reports should be prepared annually to track performance indicators for strategy implementation. Every five years the monitoring report will include a monitoring inventory update and evaluation of progress toward achieving the long term emissions reductions goals calculated for each strategy. It is important to monitor emissions trends at least every five years to either verify the effectiveness of the plan or, more importantly, to address a lack of progress and take action to adapt the strategy to achieve the target emission reductions. It will be important to balance monitoring efforts with strategy implementation efforts to meet the emissions reduction targets.

The following table summarizes the emissions reduction monitoring program.

Table 4-2 Emissions Reduction Monitoring						
Strategy	Goal	Performance Indicator	Monitoring Interval	Lead Responsible Implementing Agency	Potential Reductions by 2035 ($MTCO_2e$)	
					With CCA[1]	Without CCA[1]
Statewide Initiatives						
Clean Car Standards and Low Carbon Fuel Standard (Pavely I & II LCFS)	Lower emission vehicles and lower carbon fuels	Association of Monterey Bay Area Governments (AMBAG) Future updates to greenhouse gas analysis in Metropolitan Transportation Plan/Regional Transportation Plan (MTP)	5 Years	AMBAG, RTC	186,450	186,450
Renewable Portfolio Standard[2] (RPS)	50% Carbon-Free by 2035	California Public Utilities Commission (CPUC) RPS status reports.	Annual	CPUC	34,820	69,650
Statewide Initiatives Subtotal					*221,270*	*256,100*
County Climate Action Strategy						
Energy						
CCA (50% Participation, 100% Carbon-Free)	Evaluate CCA program	If a CCA is formed, program participation rates and energy portfolio	Annual	County	83,320	0
Energy Efficiency[3]	Continuation of existing programs, & Retrofits at Time of Sale ordinance	Data from AMBAG, Pacific Gas and Electric (PG&E), Central Coast Energy Services (CCES); Retrofits at Time of Sale: ordinance adoption and real estate sales data	Annual	AMBAG, PG&E, CCES, Planning, General Services	35,430	47,240
Green Business Program (GBP)[3]	Continuation and expansion of existing program	GBP Data	Annual	Public Works	12,290	23,970
Renewable Energy[3]	Continue current annual rate of installed capacity	California Solar Initiative (CSI), building permit data, and County projects	Annual	Planning, General Services, Public Works	3,520	15,060
Energy Efficiency Education[3]	Increased home energy audits, and benchmarking of commercial buildings	Number of home energy audits, number of benchmarked commercial buildings and other education program metrics	Annual	Planning, General Services, Public Works	800	1,200

Table 4-2 Emissions Reduction Monitoring						
Strategy	Goal	Performance Indicator	Monitoring Interval	Lead Responsible Implementing Agency	Potential Reductions by 2035 ($MTCO_2e$)	
					With CCA[1]	Without CCA[1]
Beyond Title 24	30% improvement over CALGreen mandatory measures	Building code adoption and permit activity	Annual	Planning	160	160
Energy Subtotal					*135,520*	*87,630*
Transportation						
Vehicle Miles Traveled (VMT) Reduction	Focus on infill, compact development , multi modal transportation improvements	Land use data within the urban area , transportation projects, census data	10 Years	Planning, Public Works	20,130	20,130
Electric Vehicle Charging	Local share of statewide goal: 5,525 EV's	Clean Vehicle Rebate Program (CVRP) Statistics	Annual	Planning, General Services, Public Works	10,590	10,590
Carpooling	5,508 additional carpoolers	U.S. Census	10 Years	Planning, RTC	3,730	3,730
Transportation Subtotal					*34,450*	*34,450*
Solid Waste						
Waste to Energy	Energy production credits to Santa Cruz County	CCA or other mechanism in place when contract expires in 2025	12 Years	General Services, Public Works	3,770	3,770
Solid Waste Subtotal					*3,770*	*3,770*
Climate Action Strategy Subtotal					**173,740**	**125,850**
Total Potential Reductions in 2035					**395,010**	**381,950**
Total Reductions Needed in 2035					**380,000**	**380,000**

Notes:

(1) CCA – Community Choice Aggregation

(2) With a CCA program the reduction from the RPS is estimated by applying the 50 percent carbon free portfolio to half of the projected electricity load in 2035. The reductions from a CCA program with a 100 percent carbon portfolio covering the other half of the projected electricity load in 2035 are reported on a separate line. Without a CCA program the reduction from the RPS is estimated by applying the 50 percent carbon free portfolio to the entire projected electricity load in 2035.

(3) If a CCA program is not feasible or is not able to be implemented, the resulting gap between our emissions reductions target and our actual reductions will require greater reductions from other energy strategies in the CAS. Accordingly, the numbers shown under the scenario without a CCA program assume the effectiveness of energy efficiency, green business, and educational programs is able to be increased 50 to 100 percent, and that the rate of installation of rooftop solar systems is increased by 600 percent.

Source: County of Santa Cruz, 2013.

4.3.4 Implementation Costs

Cost is an important factor in emissions reduction. A detailed cost-benefit analysis has not been completed. It should be noted that in nearly every case where investment is needed there are long-term financial benefits in terms of energy or fuel cost savings that eventually pay back the initial investment and create ongoing cost savings. In addition, successful implementation of many of the emissions reduction strategies will have a range of community co-benefits such as improved air quality, economic development, decreased traffic congestion, energy conservation, natural resource conservation, and improved public health. The co-benefits have not been evaluated in a quantitative manner, but can be reasonably inferred with decreased fossil fuel consumption and development of renewable energy.

There are number of potential funding sources and financing mechanisms to partially or wholly offset these costs. While specific funding sources may change over time, in general, options include federal and state government programs, the local air district, PG&E, and a number of different public and private financing mechanisms, including partnerships with other jurisdictions and organizations.

4.4 Adaptive Management

Adaptive management refers to a system of collecting information about the success of a project as it moves forward, with the expectation that the project will be adjusted in response to the monitoring information.

To remain effective, strategies must be periodically evaluated to account for new information that may be relevant to a more effective strategy. It will also be important to incorporate new information about climate change science and risk, which may have an effect on strategies outlined in the plan. New greenhouse gas reduction technologies may be developed and new mechanisms for financing or incentivizing energy efficiency and renewable energy projects may be developed. The CAS may have to be amended to comply with new State or federal legislation. All of these factors will be taken into account during the annual plan evaluation process to determine if updates to the CAS are necessary or desirable. Candidates for this responsibility include staff in General Services, Public Works, Administration, or Planning Departments, or a working group consisting of staff from various departments.

5.0 Vulnerability Assessment

5.1 Planning for Climate Change Involves Grappling with Uncertainty

The current extent of human influence on the natural processes of our environment is unprecedented, and human induced climate change as a result of increased greenhouse gas in the atmosphere is underway (Cal-Adapt, 2012b). If society is to adapt to this threat it is essential to understand not only how much the climate is likely to change and in what time frame, but also to characterize and analyze the effects of climate change (Schneider and Kuntz-Duriseti, 2002).

Much of the information that is available is in the form of projections that are based on complicated models of how natural systems will respond to increasing temperatures under different sets of assumptions, referred to as scenarios. Results are reported as ranges of change over different periods of time. For example, the study of future sea level rise by the National Academy of Sciences, 2012, projects that for the California coast south of Cape Mendocino, sea level will rise 1.6–11.8 inches (4–30 cm) by 2030 relative to 2000, 4.7–24.0 inches (12–61 cm) by 2050, and 16.5– 65.7 inches (42–167 cm) by 2100. Different ranges are reported for conditions in which future global carbon emissions continue to grow at different rates. The range of the estimates tends to be larger when a study is more local and/or is forecasting further into the future. Further, even the most sophisticated models are vastly simplified versions of the natural systems they describe, with the associated, often unquantifiable, possibility for error. However, even with uncertainty about the ultimate magnitude of the expected impacts from climate change, we can identify the types of expected impacts with enough confidence to assess our vulnerabilities and map out strategies to limit the negative effects.

It is important to note that many of the impacts we may experience will not be new situations created by previously unknown processes, but rather a worsening of hazards that the community has experienced in the past. Many of these hazards have been addressed in the County Local Hazard Mitigation Plan (LHMP), (County of Santa Cruz, 2010). For example, severe winter storms are experienced periodically in Santa Cruz County. The damage from flooding and coastal waves associated with severe winter storms may worsen as the climate changes due to higher sea levels exacerbating wave damage, coastal erosion, and coastal flooding.

Because climate change will continue to occur regardless of efforts to reduce GHG emissions, it is necessary to prepare for a range of possible effects.

This section of the CAS assesses the particular vulnerabilities of Santa Cruz County to potential impacts from climate change, with a focus on sea level rise and flooding.

The range of possible effects of climate change includes:

- *Sea Level Rise*
- *Flooding*
- *Extreme Storm Events*
- *Coastal Storm Damage, Bluff Erosion, Beach Loss and Landslides*
- *Ocean Acidification*
- *Changes in Precipitation and Climatic Water Deficit*
- *Changes in Temperatures*
- *Increase in Wildland Fires*
- *Impacts to Biodiversity and Habitat*
- *Impacts to Water Supply*
- *Impacts to Public Health*
- *Economic Impacts of Climate Change*
- *Climate Change and Social Vulnerability*

5.2 Sea Level Rise

In the decades ahead, sea level rise is likely to be the process that will generate one of the most obvious effects of climate change in Santa Cruz County, producing some of the most significant impacts on the low-lying areas along the coast. Sea level rise will gradually inundate low-lying areas, which include all of the shoreline and beach areas along the coastline that are presently closest to sea level. These areas of low elevation include Twin Lakes, Corcoran Lagoon, Moran Lake, Potbelly Beach Road, San Andreas Road at Watsonville Slough, Rio Del

Mar Esplanade and Rio Del Mar Flats, Beach Drive and Via Gaviota, and Pajaro Dunes. The low-lying area of Corcoran Lagoon is shown in Figure 5-1.

Figure 5-1: *Erosion of low-lying area near Corcoran Lagoon Apartments. Source: Photo courtesy of the Santa Cruz Sentinel, 2011.*

The greatest uncertainty is the rate at which sea level rise will occur. Several studies from respected research consortiums have used models to generate projections of how much sea level will change by 2030, 2050 and 2100, both globally and closer to home. The analyses model various scenarios of how much greenhouse gas is contributed to the atmosphere in the future.

The three most prominent studies are from the Intergovernmental Panel on Climate Change (2007), The Pacific Institute (Heberger et al. 2009) and the National Academy of Sciences (2012). It should be noted that the most recent study, prepared by the National Academy of Sciences (2012), includes projections for the coast of California, south of Cape Mendocino, which are more geographically specific than previous studies. The "range" of the amount of potential sea level rise in this area is greater than that indicated by previous studies, that is, it includes both lesser and greater amounts of sea level rise as possible outcomes. In the 2012 National Academy of Sciences study, the National Research Council committee projects that for the California coast south of Cape Mendocino, sea level will rise 1.6–11.8 inches (4–30 cm) by 2030 relative to 2000, 4.7–24.0 inches (12–61 cm) by 2050, and 16.5– 65.7 inches (42–167 cm) by 2100. It should be noted that there are major sources of uncertainty in the regional projections related to assumptions about future ice losses and a constant rate of vertical land motion over the projection period. In addition, uncertainties are larger for regional projections than for global projections.

Also of note, in the time between this most recent study and the IPCC study from 2007, observed conditions indicate that the curves that will be most applicable going forward are those that assume the highest levels of continued greenhouse gas emissions worldwide, and which indicate higher levels of sea level rise.

The IPCC developed several long-term Global Emissions Scenarios for Greenhouse Gases in 1990 and 1992. These are attached as Appendix E.

Vulnerability of the Santa Cruz County Coastline to Future Sea Level Rise

Impacts from rising sea level will accelerate coastal erosion, increase the extent of coastal inundation, increase localized elevated groundwater levels, and magnify the impacts of extreme storm and wave events including El Niño[5] events.

The following section discusses how sea level rise, alone or in combination with other changes, could result in adverse impacts on wastewater/sanitary infrastructure, transportation infrastructure, and residential and commercial property. A 2012 study prepared by the National Academy of Sciences projects that sea level will rise 1.6–11.8 inches (4–30 cm) by 2030 relative to 2000, 4.7–24.0 inches (12–61 cm) by 2050, and 16.5–65.7 inches (42–167 cm) by 2100 (National Research Council, 2012). The following discussions refer to a range of sea level

[5] An El Niño is a temporary change in the climate of the Pacific Ocean, in the region around the equator. This affects both the ocean and atmosphere, generally during the northern hemisphere winter. Typically, the ocean surface warms up by a few degrees Celsius. These small changes in ocean temperature can have large effects on the world's climate.

rise for the years 2030, 2050, and 2100. A reference elevation and year is needed to describe when different areas may become vulnerable to inundation, erosion and/or other hazards. This study was chosen because it is now considered the best available science for the State of California as of 2012.

The Monterey Bay Sanctuary Research Foundation, funded by a grant from the State Coastal Conservancy, is conducting the "Monterey Bay Sea Level Rise Vulnerability Assessment" which is assessing the vulnerability of Monterey Bay communities to sea level rise. This work will result in a set of digital maps and GIS data sets that will enable calculation and mapping of coastal flooding and erosion hazards under existing and future conditions to 2100. This study, which is expected to be completed in late 2013, will refine and perhaps extend the following discussion. The results will be incorporated into this CAS when they are available.

Wastewater/Sanitary Infrastructure

City of Sana Cruz Neary Lagoon Wastewater Treatment Plant

Santa Cruz County Sanitation District customers generate approximately 5-6 million gallons of sewage a day, which is transported from the District's Lode Street facility to the City of Santa Cruz Neary Lagoon wastewater treatment plant for treatment and disposal. The ocean outfall from Neary serves portions of the County as well as the City of Santa Cruz and Scotts Valley.

Groundwater level at the Neary Lagoon Wastewater Treatment Facility is very high. The anticipated rise in groundwater due to sea level rise may adversely impact the facility by impacting storage tanks and associated infrastructure (City of Santa Cruz, 2011). A large underground pump gallery is also susceptible to groundwater impacts through infiltration of groundwater through electrical conduits and cracking walls (City of Santa Cruz 2011).

Santa Cruz County Sanitation District Sewer Infrastructure

Numerous pump stations and associated sanitary sewer infrastructure operated by the Santa Cruz County Sanitation District are situated in locations vulnerable to winter storm damage. It is expected that several of these facilities may be increasingly impacted as sea level rises and storms increase. The sanitary sewer collection system contains approximately 200 miles of sanitary sewer pipeline. Approximately 188 miles of pipeline are gravity mains, and approximately 14 miles are force mains. The Santa Cruz County Sanitation District operates 37 sanitary sewer pump stations, eight of which are located close to sea level. The Santa Cruz County Sanitation District's main pump station along the transmission main to the wastewater treatment plant is the D. A. Porath Wastewater Facility located at 2750 Lode Street near 27th Avenue in Live Oak. That facility pumps sewage from the entire district to the City of Santa Cruz for treatment (LAFCO 2011). No impacts from sea level rise are expected to the Lode Street facility.

Table 5-1: Sanitary Sewer Pump Stations Located Near Sea Level

Pump Station	Approximate Elevation in Feet (amsl)	Pump Station Size
Schwan lake	16	Minor Pump Station
14th	18	Minor Pump Station
Moran	18	Minor Pump Station
Aptos 1	16	Minor Pump Station
Aptos Esplanade	14	Major Pump Station
Aptos 3	18	Minor Pump Station
Rio Del Mar/Hidden Beach	28	Major Pump Station
Sand Dollar Lower*	20	Minor Pump Station

Notes: Major Pump Station = 3 to 5 million gallons per day.
Minor Pump Station = Less than 100 connections.
Amsl – above mean sea level
*County Service Area #5 Pump Station. Not in Santa Cruz County Sanitation District.
Source: County of Santa Cruz Sanitation District, 2012.

The Santa Cruz County Sanitation District pump stations located close to sea level are listed in Table 5-1. All of the pump stations listed in Table 5-1 with the exception of Rio Del Mar/Hidden Beach have the potential to be impacted through either coastal erosion or flooding from wave run-up during a severe storm or El Niño (e.g., 1982-83) with an added 16.5–65.7 inches of sea level rise anticipated by the year 2100. Flooding has the potential to impact the operation of the pump station and coastal erosion could undermine the facility.

Coastal Transportation Infrastructure

East Cliff Drive at Twin Lakes State Beach will have increased susceptibility to coastal flooding and inundation. The roadway currently floods during large storm events, and the vulnerability is increased during El Niño conditions. Although portions of East Cliff Drive at Pleasure Point have been armored, the bluff may continue to be impacted over the coming decades due to sea level rise combined with future El Niño events. Smaller ocean front streets such as Sunny Cove, Geoffroy Drive, 23rd Avenue and Rockview in Live Oak; as well as the ocean end of north-south oriented streets, will be vulnerable to damaging storm waves which, once again, are expected to occur more frequently and with greater intensity (Storlazzi and Wingfield, 2005).

Roads at the top edge of coastal bluffs are vulnerable to damage because the rate of retreat of unprotected coastal bluffs is expected to increase in response to increased exposure to storm waves and intense rain events. For example, the portion of Seacliff Drive overlooking Seacliff State Beach in Aptos has a high potential for impacts from coastal bluff erosion. Virtually the entire length of the cliff along Seacliff Drive experienced as much as 15 feet (4.6 meters) of retreat of the top edge of the cliff during the 1997-98 El Niño; these storm-induced failures occurred in the same locations as previous failures (USGS, 2002). Roads at low elevations at the back beach and the subsurface infrastructure within the roads are also particularly vulnerable to coastal erosion. These roads include Las Olas Drive, Via Gaviota, Pot Belly Beach Road, and Beach Drive.

Flooding of the Pajaro River at both Beach Road and Shell Road at Pajaro Dunes, which currently occurs periodically, is expected to worsen and occur more often as sea level rises. Specifically, more frequent flooding will likely occur on Beach Road near the entrance to Pajaro Dunes where it currently floods periodically. Flooding is also expected to occur within a portion of San Andreas Road located between Watsonville Slough and Beach Road.

Impacts to coastal transportation infrastructure could result in delays in emergency response vehicles if the road is either flooded or washed out. Additional response time may be required by police, ambulance and fire if a detour is necessary. Some roadways such as Las Olas Drive and Beach Drive may be entirely isolated due to flooding or a landslide, making it extremely difficult for emergency response personnel to access in a timely manner. In addition, most roadways also contain numerous underground utilities that may be impacted by a landslide or erosion. This type of damage could result in a large number of residents and businesses in the vicinity without communications or utilities.

Oceanfront Residential and Commercial Properties

The effects of rising sea level can be exacerbated by El Niño occurrences. Sea level along the California coast often rises substantially during El Niño winters, when the eastern Pacific Ocean is warmer than usual and westerly wind patterns are strengthened. A compounding element as the sea level rises is the continued occurrence of winter north Pacific storms, which elevate sea level due to wind and barometric effects, especially during high tides (City of Santa Cruz, 2011). Most of the major historic storm damage along Seacliff and Rio Del Mar has been during El Niño events, and when storm waves arrive simultaneous with high tides and elevated sea levels (e.g., 1982-83 El Niño; see Figure 5-2).

The projected rise in sea level would put most Santa Cruz County oceanfront properties at greater risk from either inundation and/or coastal flooding, or from increased bluff erosion. Unincorporated Santa Cruz County has

approximately 29 miles of coastline. Approximately 3 miles of the most intensively developed coastline with primarily residential uses is located in the mid-county community of Live Oak. An additional 3 miles of vulnerable beaches with extensive coastal residential and commercial development occurs from Seacliff to Rio Del Mar.

Figure 5-2: *Damaged homes near Seacliff State Beach and Rio Del Mar during the 1982-83 El Niño.*
Source: Photo courtesy of Gary Griggs.

Some of the most vulnerable areas that would be impacted by sea-level rise in the unincorporated County due to their low coastal elevation are the Rio Del Mar Esplanade/Flats and the many beach front homes located on Pot Belly Beach Road, Las Olas Drive, Beach Drive and Via Gaviota. Under an El Niño condition or storm similar to what was experienced in 1982/83, with the addition of 16.5–65.7 inches of sea-level-rise, most of the commercial and residential areas within the Esplanade would flood. Many of the beachfront homes would also experience varying levels of storm damage and flooding depending upon their elevation, the amount and type of coastal armoring they have protecting them, and other factors. The Seascape Resort development, which is located to the south of Rio Del Mar, would not be vulnerable to sea level rise or coastal erosion due to the generous setback from the face of the bluffs. However, additional vulnerable properties are located along the bluffs in La Selva Beach on Ocean View Drive, The Shore Line, Lily Way, and Sunset Drive. Pajaro Dunes, located at the extreme south end of the County, fronts approximately 1.7 miles of coastline that is vulnerable to sea level rise, coastal flooding, and severe erosion of the dunes on which the homes are constructed.

5.3 Flooding

Flooding and coastal storms present similar risks and are usually related types of hazards in the County of Santa Cruz. Coastal storms can cause increases in tidal elevations (called storm surge), wind speed, coastal erosion, and debris flows, as well as flooding.

During a flood, excess water from rainfall or storm surge accumulates and overflows onto creek banks, beaches, and adjacent floodplains. Floodplains are lowlands adjacent to rivers, lakes and oceans that are subject to recurring floods. Many factors determine the severity of floods, including amount, intensity and duration of rainfall, creek and storm drain system capacity, soil moisture, and the infiltration rate of the ground.

A flood occurs when a waterway receives a discharge greater than its conveyance capacity. Floods may result from intense rainfall, localized drainage problems, tsunamis, or failure of flood control or water supply structures such as levees, dams or reservoirs. Floodwaters can carry large objects downstream with a force strong enough to break utility lines and destroy stationary structures such as homes and bridges. Floodwaters also saturate earth materials, which can result in the instability, collapse and destruction of structures as well as the loss of human life (County of Santa Cruz, 2010).

Most of the known floodplains in the United States have been mapped by the Federal Emergency Management Agency (FEMA), which administers the National Flood Insurance Program (NFIP). Information about floodplains in Santa Cruz County can be found in FEMA's most recent Flood Insurance Study (FIS) and on the Flood Insurance Rate Maps (FIRM). The County FIRM maps are located at http://gissc.co.santa-cruz.ca.us/default.aspx. A small-scale version of all the FIRM panels for the County is provided in Figure 5-3.

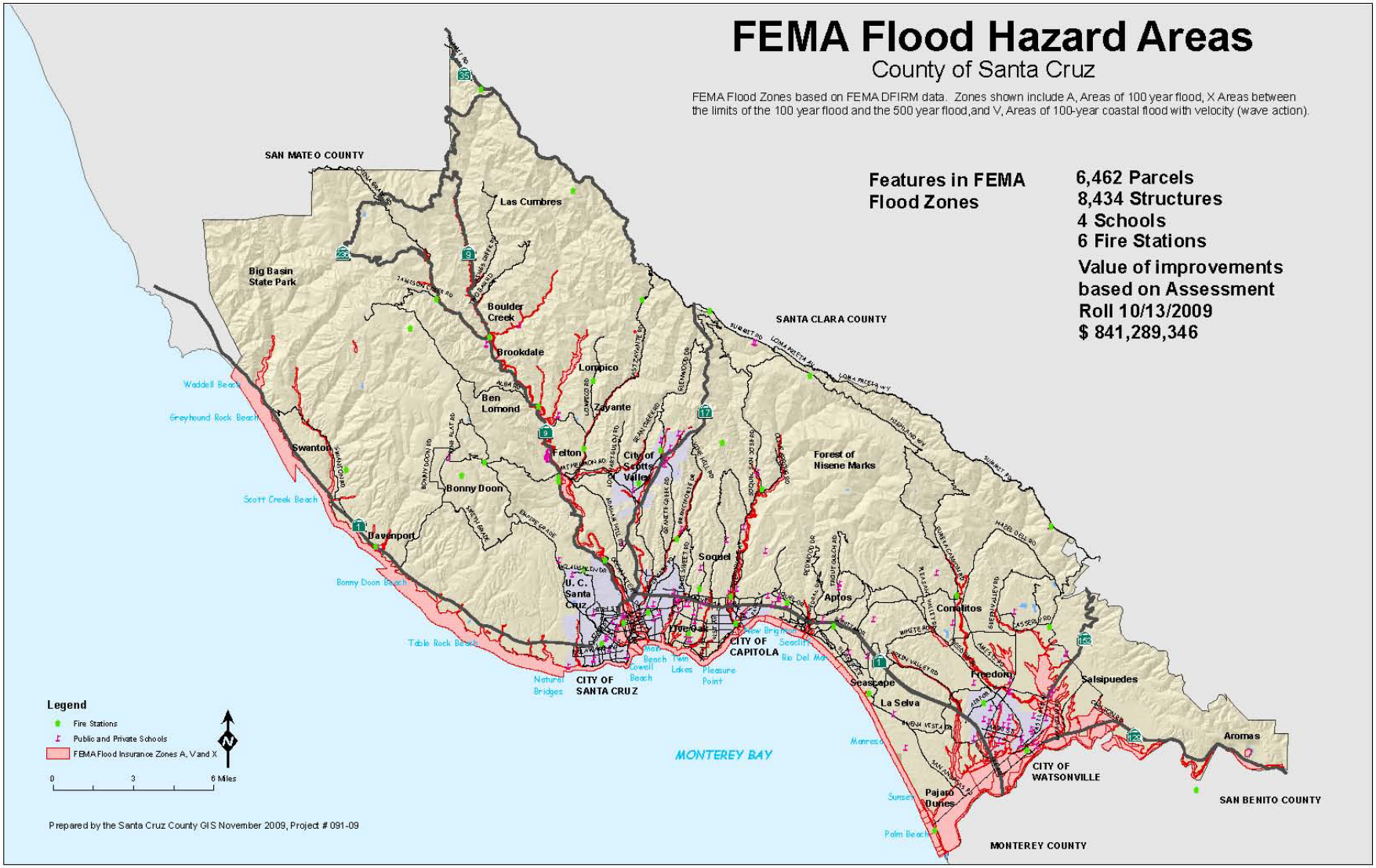

Figure 5-3: County of Santa Cruz FEMA Flood Hazard Areas
Source: County of Santa Cruz, 2009.

Two main rivers in the County that are subject to flooding are the Pajaro River and its tributaries (Corralitos and Salsipuedes creeks), and the San Lorenzo River. The Pajaro River and its floodplain run through agricultural lands within the Pajaro Valley, and through downtown Watsonville. The San Lorenzo River runs through the heavily populated San Lorenzo Valley into downtown Santa Cruz.

Other major creeks in Santa Cruz County adjacent to rural and urban development that are subject to flooding include Aptos Creek, Scott Creek, San Vicente Creek, Valencia Creek, Soquel Creek, Branciforte Creek and their tributaries. The steepness of many of these creek canyons and the surrounding mountain areas results in relatively short warning times, increasing the hazard for those at risk. There are also many smaller creeks and tributaries throughout the County that are subject to flooding. Most of these are tributaries to the major creeks and rivers noted above.

Areas of low-density development characterize most creeks along the North Coast of Santa Cruz County. Flooding of developed areas from storm surges is unlikely in this area, since development has occurred mainly on cliffs and inland of the coastal flood areas. While flooding is still a risk in these areas, there are no occurrences of repetitive loss of property from flooding along the North Coast.

Coastal flooding along the heavily developed Monterey Bay coastline of Santa Cruz County may occur with the simultaneous occurrence of large waves and storm swells during the winter. Storms from the southwest direction produce the type of storm pattern most commonly responsible for the majority of severe coastline flooding. The strong winds combined with high tides that create storm surges are usually accompanied by heavy rains. When storms occur simultaneously with high tides, flood conditions, particularly flooding at the mouth of the Pajaro River and Aptos Creek, are exacerbated (County of Santa Cruz, 2010).

Flooding in Santa Cruz County has occurred in each of the primary drainages and will continue to occur in the future given the right set of meteorological conditions. Previous floods are well documented for all primary drainages with the exception of Aptos Creek, which is not gauged. Major storms and associated flooding have occurred during March 1899, December 1937, February 1940, November 1950, January 1952, December 1955, April 1958, January 1963, January 1967, January 1973, and January 1982. The December 1955, January 1982, and January 1995 storms were the most severe in recent times. As a result of climate change, seasonal precipitation patterns, including timing, intensity, and form of precipitation, are projected to shift. A recent study conducted by the U.S. Geological Survey projects that there will be a shift in peak precipitation from January to February, with less precipitation occurring in the fall (November-December) and spring (March-April) by 2100. The U.S. Geological Survey (USGS) also concluded that while the amount of annual precipitation is not expected to substantially change as a result of climate change, precipitation will be concentrated in mid-winter (Flint, L.E., and Flint, A.L., 2012). As a result, flooding is a growing threat that deserves careful attention as one of the more hazardous impacts of climate change.

Santa Cruz County's geography focuses rainfall into four primary watersheds: the San Lorenzo River; Soquel Creek; Aptos Creek; and Corralitos/Salsipuedes Creeks. While the Corralitos/Salsipuedes watershed feeds into the Pajaro River and can be a crucial element in exposure to flooding of the Pajaro in the Watsonville area, the Pajaro's drainage is predominantly from Southern Santa Clara, San Benito, and Monterey Counties.

Geographically, the San Lorenzo, Soquel, Aptos, and Corralitos/Salsipuedes drainages are relatively short and steep compared to the Pajaro River drainage system, and have significantly shorter times of concentration and therefore shorter warning times for peak flow incidents. Under a widespread heavy rain scenario (accumulations of 0.30 inches of rain per hour or more), severe flooding is likely on low-lying areas within the basin (County of Santa Cruz, 2010). Based on the 100-year flood plain (Federal Emergency Management Agency - FEMA Zone A), 6,462 developed parcels, 8,434 structures, 6 fire stations, and 4 public schools are located within or

intersected by the 100-year flood plain (Figure 5-3). These projected flooding impacts will become more widespread as the climate warms and the 100-year flood plain expands.

As intense rainfall events and flooding increase, extreme runoff periods will also become more common. However, infiltration is not expected to overwhelm sewers and centralized sewage treatment infrastructure, because extensive improvements to raise treatment capacity at the Neary Lagoon Wastewater Treatment Plant have been completed (City of Santa Cruz, 2011).

5.4 Extreme Storm Events

In the first three months of 1983, the west coast of the United States experienced a sequence of strong storms, with the coincidence of El Niño conditions, high astronomical tides, and large waves producing record sea levels along virtually the entire coast. Damage was extensive (e.g., Figure 5-4), with losses totaling $215 million (in 2010 dollars; Griggs et al., 2005). Some models predict that such extreme events will become more common and that heightened sea level will persist longer as sea level rises, increasing the potential for damage (Cayan et al., 2008; Cloern et al., 2011).

Figure 5-4: *The Rio Del Mar Esplanade was damaged during the El Niño winter of 1983 by large waves arriving simultaneously with high tides and elevated sea levels.*
Source: Gary Griggs, University of California, Santa Cruz.

The National Research Council committee reproduced the study by Cloern et al. (2011) using its own sea-level projection for the San Francisco area and the Geophysical Fluid Dynamics Laboratory CM2.1 model. This exercise showed that as mean sea level rises, the incidence of extreme high-sea-level events becomes increasingly common (Figure 5-5). According to the model, the incidence of extreme water heights that exceed the 99.99th percentile level (1.41 meters [55 inches]) above historical mean sea level) increases from the historical rate of approximately 9 hours per decade to more than 250 hours per decade by mid-century, and to more than 12,000 hours per decade by the end of the century. The model also shows that the duration of these extremes would lengthen from a maximum of 1 or 2 hours for the recent historical period to 6 or more hours by 2100, increasing the exposure of the coast to waves (National Research Council, 2012).

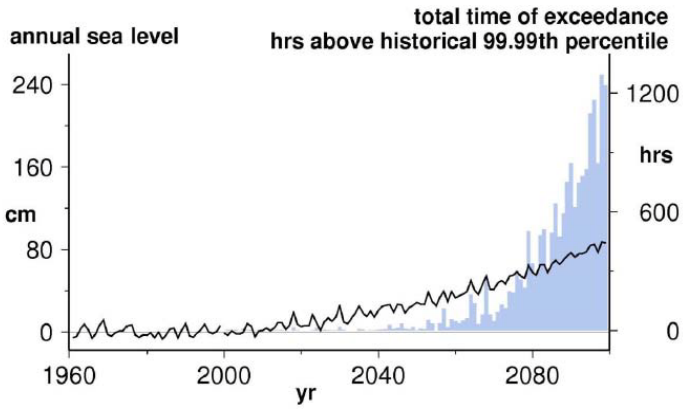

Figure 5-5: *Projected number of hours (blue bars) of extremely high sea level off San Francisco under an assumed sea-level rise and climate change scenario. In this exercise, a sea-level event registers as an exceedance when San Francisco's projected sea level exceeds its recent (1970–2000) 99.99th percentile level, 1.41 meters (55 inches) above historical mean sea level. In the recent historical period, sea level has exceeded this threshold about one time (1 hour) every 14 months. Sea-level rise (black line) during 1960–1999 was arbitrarily set to zero, then increased to the committee's projected level for the San Francisco area over the 21st century (92 cm).*
Source: Adapted from Cloern et al. (2011).

5.5 Coastal Storm Damage, Bluff Erosion, Beach Loss and Landslides

An increase in future coastal storm frequency and/or intensity will increase cliff retreat rates as well as cause potential damage to oceanfront property or public infrastructure. The coastline of northern California, Oregon and Washington have experienced increasingly intense winter storms and greater wave heights over the last 25 years, both of which may be leading to more severe

winter erosion (Allan and Komar, 2000). While there is no consensus yet on why storms have been getting stronger, data from wave gauges off the coasts of Oregon and Washington indicate that over a 25 year period from 1975 to 2000, average wave heights have increased from approximately 10 feet to about 13 feet. Over the same period, maximum storm wave heights increased from 36 feet to nearly 50 feet. Greater wave heights when combined with higher sea levels would mean greater erosion at the shoreline.

Storlazzi and Wingfield (2005) of the USGS Pacific Science Center in Santa Cruz recently completed a similar evaluation of changing wave conditions along the central California coast. They analyzed hourly wave data from eight different National Oceanic and Atmospheric Administration (NOAA) buoys deployed off central California between Point Arguello (north of Point Conception) and Cape Mendocino since the early 1980s to determine if and how wave conditions may have changed over the subsequent 22 years. They concluded that wave heights are greater during El Niño months. During the 22 years of recorded wave data examined, monthly significant wave heights (the average of the highest one-third of the waves and a standard index of wave height) increased about 2 cm/year throughout the offshore area. In other words, average wave heights increased about 1.4 feet over the past 22 years. This period was also characterized by a warm Pacific Decadal Oscillation (PDO) cycle dominated by more frequent El Niño conditions. It not yet clear what this means over the long-term, but the trend along the entire Pacific coast has been one of increasing wave heights.

5.5.1 Vulnerability of Santa Cruz County Coastline from Storm Damage

In striking contrast to the slow erosion of hard rocks, erosion can be far more rapid (over 1 foot (30 cm) per year, on average) where the bluffs consist of weaker sedimentary rocks such as shale, siltstone, sandstone, or unconsolidated materials such as dune sand or marine terrace deposits. In these areas cliffs often retreat in a linear fashion, producing relatively straight coastlines. Lithologic, stratigraphic and structural weaknesses or differences are the key factors affecting erosion rates in sedimentary rocks. Cliff erosion is due not only to waves undercutting the base of the cliff, but also to rockfalls, landsliding and slumping higher on the cliff face, often as a result of weakening due to groundwater percolation. The orientation and spacing of joints in the sandstones, siltstones, and mudstones that make up the cliffs surrounding northern Monterey Bay are the dominant factors affecting cliff retreat in this area (Griggs, G.B. and Johnson, R.E. 1979).

The following areas along the unincorporated Santa Cruz County coastline are highly susceptible to damage due to greater intensity of storms associated with climate change.

Twin Lakes Area

The coastline extending from Santa Cruz Harbor to 15th Avenue is expected to face severe winter beach erosion and storm damage by the year 2100 with the projected 16.5–65.7 inches of sea level rise (Figure 5-6). Under a severe storm or El Niño condition as experienced in 1982-83, with the addition of wave run-up and the anticipated sea level rise by 2100, severe flooding and coastal erosion is anticipated. At a roadway elevation of approximately 12 feet above mean sea level (amsl) on E. Cliff Drive at Schwan Lagoon, increased sea level combined with an El Niño condition and more severe storm activity, E. Cliff Drive and many of the residences fronting the roadway along the beach could be severely impacted by flooding and coastal erosion.

Figure 5-6: *Twin Lakes State Beach at Schwan Lagoon*
Source: California Coastal Records Project, 2012.

Corcoran Lagoon

The coastline extending from 20th Avenue to Corcoran Lagoon is also expected to face severe beach erosion during winter months by the year 2100, with the projected sea level rise (Figure 5-7). Under a severe El Niño condition or storm event (as experienced in 1982-83) with wave run-up and the anticipated sea level rise, E. Cliff Drive and many of the low-lying oceanfront residences could experience flooding and coastal erosion. The Corcoran Lagoon Apartments shown in Figure 5-7 would be particularly vulnerable to storm damage and flooding due to the low elevation of approximately 10 feet amsl.

Figure 5-7: *Corcoran Lagoon*
Source: California Coastal Records Project, 2012.

Moran Lake

The coastline fronting E. Cliff Drive at Moran Lake (particularly south of Moran Lake) is in a similar situation as Corcoran Lagoon (Figure 5-8). At a roadway elevation of approximately 16 feet amsl, increased sea level combined with and El Niño condition and more severe storm activity, E. Cliff Drive at Moran Lake and many of the residences fronting the beach could be severely impacted by flooding and coastal erosion.

Figure 5-8: *Moran Lake*
Source: California Coastal Records Project, 2012.

East Cliff Drive at Pleasure Point

For decades the County of Santa Cruz has been battling bluff erosion along East Cliff Drive at Pleasure Point (Figure 5-9). East Cliff Drive is designated as a County scenic roadway, and provides public access to the beaches along Pleasure Point as well as access to offshore surfing areas.

Based on both historic aerial photographs that extend back to 1928 and also parcel maps, long-term average annual erosion rates in the 33rd to 41st Avenues area range from about six inches to a foot annually (Griggs and Johnson 1979; Griggs, Patsch, and Savoy 2005; Griggs 1994a; Moore, Benumof, and Griggs 1999; Moore 1998), although erosion rates vary over time and with location due to differences in rock resistance.

Figure 5-9: *East Cliff Drive at Pleasure Point*
Source: California Coastal Records Project, 2012.

To protect East Cliff Drive, already reduced to a single lane of traffic, and the primary utilities that run below it, the County of Santa Cruz constructed approximately 1,100 feet of bluff protection. The project consisted of a soil nail wall and rip rap protection from 33rd Avenue to 36th Avenue, and the construction of a second 300-foot long soil nail wall at the end of 41st Avenue at the Hook. The East Cliff Drive Bluff Protection and Parkway project is intended to increase the longevity of the public right-of-way; project the road and utilities from coastal bluff erosion; and to improve and enhance public access to the

coast by constructing a parkway for pedestrians and cyclists. It is not expected that sea level rise will significantly impact the protected bluffs as long as they are maintained in their current condition.

New Brighton/Seacliff State Beach Area

The beachfront residences in the vicinity of New Brighton and Seacliff State Beaches are expected to face severe storm damage by the year 2100 with the projected sea level rise. Under a severe El Niño condition or storm event (as experienced in 1982-83) with wave run-up and the anticipated sea level rise, severe flooding and coastal erosion could occur. Because many residences are elevated at less than 20 feet amsl, increased sea level combined with and El Niño condition and a severe storm, many of the residences fronting the beach have the potential to be severely impacted by flooding and coastal erosion.

Figure 5-10: *Seacliff State Beach Debris Flow, February 6, 1998*
Source: http://walrus.wr.usgs.gov/elnino/coastal/seacliff-all.html

The waves generated by severe winter storms during the 1982-83 El Niño destroyed the wooden seawall at Seacliff State Beach for the 8th time in 60 years. Heavy rains have also had a significant impact on coastal bluffs, as the bluffs are susceptible to debris-flow type failures during heavy rains (Figure 5-10). The bluffs at Seacliff State Beach are protected from waves by a seasonally dependent, variable-width sandy beach backed by a seawall. Waves only reach the base of the cliffs during extreme storms. Therefore, the sea cliff failures and resulting cliff retreat that occur along this stretch of coast are primarily a result of terrestrial processes (overland flow, groundwater flow, and seismic shaking) (USGS 2002). Based on data compiled by Storlazzi and Griggs, 76 percent of historical storms that caused significant coastal erosion or damage occurred during El Niño years. Global climate change and sea level rise are expected to increase the severity and frequency of storms in the eastern Pacific, thereby increasing the risk to coastal bluff erosion and flooding resulting in damage to beach infrastructure and nearby residences located on Beach Drive, Las Olas Drive and Potbelly Beach Road.

Rio Del Mar Esplanade/Flats and Beach Drive

The Rio Del Mar Esplanade/Flats and the coastline fronting Beach Drive also are expected to face severe storm damage by the year 2100 with the projected sea level rise (Figure 5-11). Under a severe El Niño condition or storm event (as experienced in 1983) with wave run-up and the anticipated sea level rise, much of the residential and commercial properties located in the Rio Del Mar Flats area is likely to flood. The oceanfront residences along Beach Drive could be heavily impacted by severe wave run-up, although many of the beachfront structures have recently been improved or replaced since 1983, and now meet the current 100-year FEMA requirements.

Figure 5-11: *Rio Del Mar Esplanade/Flats*
Source: California Coastal Records Project.

Pajaro Dunes

Figure 5-12: *Pajaro Dunes Pelican Point Condominiums*
Source: California Coastal Records Project.

The largest beachside development in the area, Pajaro Dunes, consists of 396 condominiums, 24 townhouses, and 145 single-family dwellings (Figure 5-12). All units are built on the active sand dune, with many of the structures built directly on the foredune above the beach or on the beach itself. The pattern in this area over the past 50 to 75 years, which is evident in historical aerial photos, is one of dune erosion during severe storms, followed by gradual build-up of sand during the subsequent calmer years. Thus, although there does not appear to be significant net retreat of shoreline, the advance and retreat of the dunes may move the shoreline 40 or 50 feet during a single winter. Unfortunately, the condominiums and homes do not shift with the dunes. Since the development was initiated in 1969, four major El Niño winters (1978, 1980, 1982-83, and 1997-98) have brought large waves from the west and southwest, combined with storm elevated sea levels, and significantly eroded the dunes. The January 1983 storms cut back the dunes up to 40 feet and left a near-vertical cut measuring 15 to 18 feet that came right to the foundations of many of the homes. Only the emergency emplacement of thousands of tons of rock saved these homes from disaster. At the end of the storm season, a permanent revetment was built along the seaward frontage of this development at a cost of several million dollars. Although the revetment has provided some protection, by the time the 1997-98 El Niño hit Pajaro Dunes, much of the revetment was scattered across the beach. Any resemblance to the original, natural dune environment has disappeared (Griggs, et al., 2005). Impacts associated with 16.5–65.7 inches of sea level rise in combination with a severe storm or El Niño event could result in additional dune erosion and flooding from wave run-up, adversely affecting the residences and condominiums once again.

5.5.2 Vulnerability of Santa Cruz County Beaches from Climate Change

Figure 5-13: *Rio Del Mar Beach Erosion*
Source: Santa Cruz Sentinel, January 2011.

Practically speaking, the entire coast of California has been retreating or eroding for the past 18,000 years. There is an important distinction, however, between the erosion or retreat of coastal cliffs or bluffs, which is an irreversible process, and the seasonal or longer term erosion of the beaches, which can be recoverable. Thus, even as the coastline continues to retreat landward, beaches will be present as long as the supply of sand to the shoreline is maintained. When the shoreline of California was 10 miles (16 km) to the west, there were beaches on the outer edge of the continental shelf. As sea level rose and the shoreline moved eastward, the beaches migrated with the shoreline because sand continued to be provided by rivers, streams and cliff erosion (State of California, 2002). Figure 5-13 shows the beach erosion at Rio Del Mar Beach that occurred following a substantial storm. Sand was moved offshore during large storm surges and high flows from the mouth of Aptos Creek.

During 1982-83 El Niño storms, Seacliff State Beach was severely eroded. Cross-shore profiles obtained by U.S. Geological Survey scientists (Figure 5-14) show that normal wave activity in succeeding years re-deposited sand, rebuilding the beach (USGS, 2000).

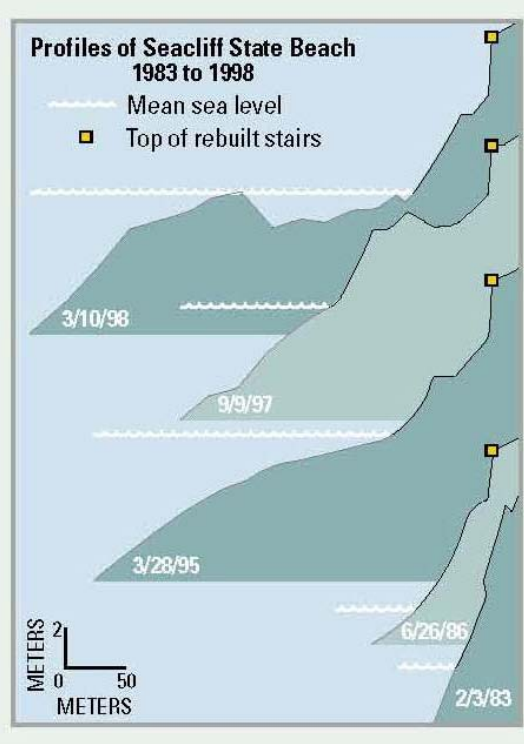

Figure 5-14: *Profiles of Seacliff State Beach 1983-1998*
Source: USGS 2000.

5.5.3 Vulnerability of Santa Cruz County from Increased Landslides

An anticipated increase in precipitation during midwinter months (December and January) may lead to increased impact to roadways and residences from flooding and landslides (Flint, L.E., and Flint, A.L., 2012). Several notable landslides have occurred in Santa Cruz County in recent history. Some of the better-documented landslides include:

Mount Hermon Landslide: The Mountain Hermon landslide moved in the late 1950's after the El Niño year of 1957–1958. This landsliding occurred in an area of suspected older landsliding and the new movement in 1982-83 extended from the Kaiser Quarry to the bottom of Bean Creek blocking Mount Hermon Road, and is one of the reasons for construction of the Mount Hermon bypass.

Rain Storms of January 1982: Severe storms caused multiple landslides throughout the Bay Area and especially in the Santa Cruz Mountains. One very large composite landslide along Love Creek, west of Loch Lomond Reservoir, destroyed a neighborhood and killed ten people. Other landslides, including debris flows, destroyed homes and were responsible for the deaths of several other people. In addition to damage to homes, widespread landslide damage occurred to roadways, driveways, and stream channels.

El Niño Winter Storms of 1983, 1986, 1998, and 2005: These storms caused multiple landslides, particularly debris flows, throughout the Santa Cruz Mountains. During the 1998 winter, many homes were affected by landsliding and several roadways were damaged including Highway 9, Branciforte Road, El Rancho Drive, and Amesti Road. Winter rains also induced landsliding within quarries located throughout the County.

Nelson Road March 2011 Landslide: Saturated soils resulted in a landside of approximately 200 to 300 hundred feet long and about 150 feet wide. It wiped out a power line and cut off about 25 homes from the main road. A temporary access road was constructed to allow access to the stranded homes during debris removal. A permanent bypass is under design with an estimated construction cost of $1.5 million.

5.6 Ocean Acidification

Ocean acidification describes the increase in the acidity of the global oceans resulting from the uptake of human generated carbon dioxide from the atmosphere. Less than half of the carbon dioxide produced by the burning of oil, gas and coal stays in the atmosphere and about a third is dissolved into the oceans. This dissolved carbon dioxide forms a weak acid (carbonic acid) in seawater making it slightly more acidic. While this process has helped remove very large quantities of carbon dioxide from the atmosphere, reducing the greenhouse effects that would have otherwise been significantly greater, it continues to make the oceans more acidic (City of Santa Cruz, 2011).

By the first decade of the 21st century, the acidity of the world oceans had increased by about 30 percent over the pre-industrial revolution level. As carbon dioxide emissions continue with the burning of additional fossil fuels (coal, oil and gas now provide about 87 percent of global energy), additional carbon dioxide will enter the oceans and pH will continue to decrease. Future rates of change will depend upon when and how rapidly the U.S. and the rest of industrialized society move away from a fossil fuel based economy (City of Santa Cruz, 2011).

It is believed that this progressive shift towards increased acidity will gradually affect organisms in the ocean that build their skeletons or shells out of calcium carbonate. Calcium carbonate dissolves in acidic solutions, so the lower the pH, the more difficult it will be for these organisms to either grow new shells or skeletons or maintain their existing health and populations. These include some of the larger and more visible organisms such as coral, sea urchins, and mollusks, but also plankton such as foraminifera, coccolithophores and pteropods. These tiny organisms are at the base of the food chain and provide the food supply for the larger plankton such as krill, which are the primary food source for salmon and other fish, as well as sea birds and baleen whales (City of Santa Cruz, 2011).

Acidification is not yet having a measureable effect on the coastal ocean off Santa Cruz. Considerable research is underway as to how these well documented patterns will affect different types of organisms and how soon. This is a global issue and while it could have some effects on the fauna of the Monterey Bay at some future time, it is beyond the reach of our community to significantly affect these global scale processes (City of Santa Cruz, 2011).

5.7 Precipitation and Climatic Water Deficit

5.7.1 Precipitation

The City of Santa Cruz has a recorded rainfall history that goes back to 1868. The average annual rainfall for the city over this 138-year period is 28.5 inches, and yearly totals range from a low of 10.2 inches in 1924 to a maximum of 61.3 inches in 1941. There are well-documented dry periods with below average rainfall that extended for three or more years in a row, and also wetter periods with rainfall remaining above average for at least three years in a row. Over the past 138 years, however, there is no recognizable trend towards an increase in rainfall. The main trends tend to be higher average rainfalls during warm Pacific Decadal Oscillation (PDO) cycles (1978-2000) and lower average rainfalls during cooler PDO cycles (1945-1978) (City of Santa Cruz 2011).

A recent study, "Simulation of Climate Change in San Francisco Bay Basins, California: Case Studies in the Russian River Valley and Santa Cruz Mountains", Flint, L.E., and A.L. Flint, U.S. Geological Survey, 2012, concludes that for Santa Cruz County annual precipitation may slightly increase or slightly decrease a the climate changes, depending on the hydrologic model, but that in either case rain will be compressed into mid winter months, which will create drier than normal conditions in the fall and spring. The study also concluded that more than one drought every decade is anticipated, where historically only about 4 to 5 droughts occurred over a 90 year period. These changes have implications for flooding, water supply, and habitat.

5.7.2 Climatic Water Deficit

Climatic water deficit is an estimate of drought stress on soils and plants. It integrates several variables, including solar radiation, evapotranspiration, soil moisture from precipitation, and air temperature. In a Mediterranean climate, climatic water deficit can be thought of as a proxy for water demand based on irrigation needs, and changes in climatic water deficit effectively quantify the supplemental amount of water needed to maintain current vegetation cover, whether natural vegetation or agricultural crops (Flint, L.E., and A.L. Flint, 2012).

The U.S. Geological Survey (USGS) (Flint, L.E. and A.L. Flint, 2012) evaluated potential changes in climate, evapotranspiration, recharge, runoff, and climatic water deficit in the Santa Cruz Mountains. The study was carried out in collaboration with the County of Santa Cruz, Environmental Health Services. The study finds that

the San Francisco Bay Area has experienced a warming trend over the 20th century, and monthly maximum temperatures have increased approximately 1.8°F (1°C) between 1900 and 2000. In general, coastal influences mitigate the warming trend, and effects are more pronounced with increasing distance from the Pacific coast or the bay. Projected temperature trends showed greater agreement than projected precipitation trends.

As noted in section 5.7.1, the hydrologic modeling predicts reduced early and late wet season runoff for the end of the century which could result in an extended dry season and an increased risk of floods in the wet season. Summers are projected to be longer and drier in the future regardless of whether precipitation increases, decreases or is unchanged. As a result of this precipitation pattern water supply could be subject to increased variability, that is, reduced reliability, while water demand is likely to increase during the extended summers. Climatic water deficit is expected to increase as much as 30 percent between 2071 and 2100. In some locations in the County approximately 8 inches (200 millimeters) of additional water may be needed on average to maintain current soil moisture conditions and the current level of climatic water deficit. Extended dry season conditions and the potential for increased drought could also place additional stress on water quality and habitat (Flint, L.E., and A.L. Flint).

The results of this study, which will be integrated into water supply management plans, indicate that water supply may become less dependable and that plants, redwood trees in particular, may be displaced. Biotic impacts of potential changes in the precipitation regime are discussed further in section 5.10.

5.8 Changing Temperatures

Increased greenhouse gases in the atmosphere raises temperatures and alters seasonal temperature patterns. Effects can include changes in average temperature, the timing of seasons, and the degree of cooling that occurs in the evening. In addition to new seasonal temperature patterns, extreme events such as heat waves are projected to occur more frequently and/or last for longer periods of time. Changes in average temperature, when evaluated on large scales (state, national, or global), have a fairly high level of certainty with consistency among various models (State of California 2012b).

According to the Flint, L.E. and A.L. Flint, (2012) study, maximum air temperature in the Bay Area has steadily risen over the last century by 1.8°F (1°C), and all model and scenario projections indicate it will continue to rise. The air temperature projections for the 21st century showed increases from 3.6 to 7.2°F (2 to 4°C) in the Bay Area, but the B1 emissions scenario estimates were less than from the A2 scenario (see Appendix E for descriptions of IPCC scenarios). Decadal (10-year) averages of air temperature in the Bay Area showing historical and future temperatures generated by the global climate models are presented in Figure 5-15.

5.9 Increase in Wildland Fires

Santa Cruz County is ranked 9th among 413 western state counties for percentage of homes in the Wildland Urban Interface (WUI) and 14th among 58 counties in California for fire risk (Headwaters Economics, 2008). Areas such as vacant lots, highway medians, parks, golf courses and rural residential areas describe many areas considered to be WUI. Climate change is expected to result in a low to moderate risk of increases in fire frequency, size, and severity beyond the historic range of natural wildfire variability due to increasing length of the fire season, drier fuels, and decreasing forest health. These changes are being driven by alterations in temperature and precipitation regimes to a warmer and drier condition. In general, the statistical fire model predictions show a greater change in the probability of burning in the distant future (2070–2099) than near future (2010–2039), as would be expected from the greater changes in climate by the end of the century (Krawchuk and Moritz, 2012).

The size, severity, duration and frequency of fires are greatly influenced by climate. Although fires are a natural part of the California landscape, the fire season in California and elsewhere seems to be starting sooner and

lasting longer, with climate change being suspected as a key mechanism in this trend (Flannigan et al., 2000; Westerling et al., 2006). The rolling five year average for acres burned by wildfires within all jurisdictions increased in the past two decades from 250,000 to 350,000 acres (1987–1996) to 400,000 to 600,000 acres (1997–2006) (2006, California Wildfire Activity Statistics). In addition, the three largest fire years since 1950 have occurred this past decade, with both 2007 and 2008 exceeding the previous five-year average (California Department of Forestry and Fire Protection, 2010). Wildland fires are influenced by three factors: fuel, weather and topography. Wildlfire spread depends on the type of fuel involved (grass, brush and trees). Weather influences wildland fire behavior with factors such as wind, relative humidity, temperature, fuel moisture and possibly lightning. Several of these factors can modify the rate the fire will burn. Topography is the biggest influence on fire severity (County of Santa Cruz, 2010).

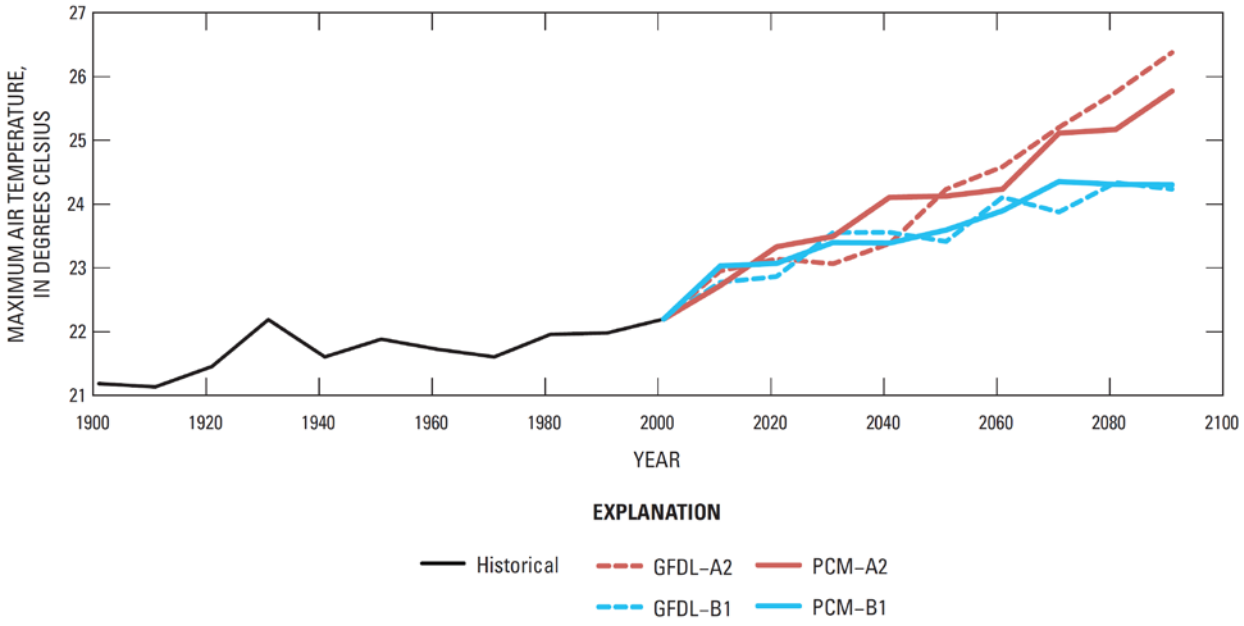

Figure 5-15: *Historical climate and four projections shown by decadal (10-year) average maximum air temperature for the basins in the San Francisco Bay Area, California.*
Source: Flint, L.E. and A.L. Flint, 2012.

In Santa Cruz County there are numerous WUI areas and several areas designated as mutual threat zones. Mutual threat zones are defined as areas where a wildfire would threaten property within the Santa Cruz County Fire Department jurisdiction as well as property covered by another fire protection service. These geographic areas are described as non-State Responsibility Areas. For major emergencies that require more resources than can be provided by a single agency, Santa Cruz County Fire, the University of California at Santa Cruz, other Fire Districts and the State of California (CAL FIRE) have an extensive mutual aid and emergency coordination system covering the entire state. This system allows departments and districts to share personnel and equipment as needed to address and control emergencies (County of Santa Cruz, 2010).

Other areas have been mapped as Critical Fire Hazard Areas due to accumulations of wildfire prone vegetation, steep and dry slopes and the presence of structures vulnerable to wildland fires. These areas are generally situated in the steeper higher elevations of the County. Most of these areas are along the border of Santa Clara County or in the coastal ridges between Highway 9 and Highway 1 (County of Santa Cruz, 2010).

The potential magnitude or severity of future fires can be estimated from experience gained from the recent fires of 2008/2009. In those fires, embers were carried by wind up to one mile, torching of conifers occurred, flame lengths exceeded 100 feet, and area ignition were all observed. In 2008, over 75 structures were destroyed by three fires alone. Similar fuels (Manzanita/Knobcone, Eucalyptus, chaparral, and mixed conifer forestland), topography and weather conditions are expected to be encountered in future fires creating a repeat of extreme fire behavior exhibited in recent large local fires (County of Santa Cruz, 2010).

While normal weather conditions in the Santa Cruz Mountains can be categorized as cold and damp with extensive marine influence (fog), several times each year conditions are created where fuel moisture levels have been measured below five percent with temperatures above 90ºF, and north winds greater than 45 mph (County of Santa Cruz, 2010).

During the past two fire seasons over 13,000 acres have burned in five major fires in Santa Cruz County (see Table 5-2). Each of these fires has burned structures and all have endangered life. Suppression costs alone for these fires have exceeded $60 million. The county endures over 200 wildland fires each year on average (County of Santa Cruz, 2010).

According to the Cal-Adapt projections for wildfire in the region due to the effects of climate change, there is expected to be a low to moderate change in wildfire risk in the central coast region with the exception of southwestern Monterey County (State of California 2012a). However, it is unknown how much the expected decrease in redwood habitat (L.E. and A.L. Flint, 2012) will affect this projection, as any vegetation community that replaces redwood forest is likely to be a higher fire risk community.

Table 5-2: Previous Wildfires within Santa Cruz County

Fire Name	Year	Acres Burned
Pine Mountain	1948	15,893
Newell Creek	1954	166
Newell Creek No.2	1959	1,326
Austrian Gulch	1961	9,067
Lincoln Hill	1962	3,234
Big Basin No.7	1980	378
Big Basin	1982	300
Rocha No.2	1984	1,239
Lexington	1985	13,122
Croy Fire	2002	3,006
Summit Fire	2008	4,270
Martin Fire	2008	520
Trabing Fire	2008	630
Lockheed Fire	2009	7,819
Loma Fire	2009	485

Source: County of Santa Cruz Local Hazard Mitigation Plan 2010-2015.

5.10 Impacts to Biodiversity and Habitat

5.10.1 Climate Change

By the end of the century, summer temperatures in Santa Cruz County are predicted to increase by up to 7°F, with a shift in local peak precipitation from January to February with less in the fall (November-December) and spring (March-April) in the future. In addition, more than one drought every decade is anticipated. Historically, about 4 to 5 droughts occurred over a 90 year period (Flint, L.E. and A.L. Flint, 2012). The increase in temperature will promote water loss due to evaporation and transpiration, creating a climatic water deficit for plants. Moreover, a continuation of the trend of 33 percent reduction in the frequency of California summer fog (Johnstone and Dawson, 2010) could exacerbate the drought stress caused by the predicted hotter and likely drier conditions (Mackenzie, A, J. McGraw, and M. Freeman. 2011).

The hotter, drier climate will affect natural biological systems through a variety of mechanisms (Table 5-3). The effects on individual species or communities can be difficult to predict as they will be influenced by many cascading, indirect effects mediated by complex species interactions. What are the consequences for a rare plant that is solely or primarily pollinated by a butterfly species that emigrates in response to a warming climate? While some studies suggest that species that presently co-occur will shift their distributions together in response to climate change such that communities will move together (Breshears et al. 2008), other studies suggest that the

unique combinations of temperature and precipitation not currently found in the region, will result in novel communities, or new assemblages of species (Stralberg et al. 2009).

Table 5-3. General Climate Change Impacts on the Biodiversity of Santa Cruz County

Terrestrial Systems
• Shift of plant and animal distributions into regions with currently cooler climate envelopes • Increased or reduced plant and animal species within their current range • Vegetation structure changes • Forests transition to shrublands • Shrublands transition to grasslands • Potentially new plant communities emerge as a result of novel climates • Increase in fire frequency, promoting fire-adapted species and eliminating fire-sensitive species • Increase in pest and pathogen outbreaks due to drought-stressed plants and more fires • Invasion and spread of non-native species
Aquatic Systems
• Reduced stream flow due to evaporation and lowering of groundwater • Increased variability of stream flow • Flooding due to more severe precipitation could alter channel conditions and habitat, and export nutrients and other materials • Seasonal drying up of perennial streams due to drought • Reduced depth and hydroperiod (period of inundation) in sloughs, ponds, and wetlands • Increased water temperature, reduced dissolved oxygen, and increased productivity • Changes in community composition due to shifts in species distributions and interactions • Changes in abundance in response to physical changes and species interactions • Invasion and spread of non-native species
Source: Mackenzie, A, J. McGraw, and M. Freeman. 2011.

The vulnerability of species and communities to climate change depends on their level of exposure, sensitivity, and capacity to adjust to change (Hanson and Hoffman 2011. Table 5-4 identifies types and examples of species and systems that could be most vulnerable based on five considerations (Hanson and Hoffman 2011).

According to Mackenzie, A, J. et al. (2011), of particular concern is the potential effects of climate change on fog frequency. Numerous species within Santa Cruz County are adapted to the coastal fog, which moderates summer high temperatures, creates humidity, and provides water for plant uptake during the otherwise long summer drought. Three systems, which collectively contain a high proportion of the county's biodiversity, rely on summer fog.

- *Coast Redwood Forest:* Coast redwoods (*Sequoia sempervirens*) intercept fog, using it directly and increasing soil moisture used by other species (Dawson, 1998). By adding water to the catchment basin, redwoods contribute to summer stream flows and are also critical to maintaining cool stream temperatures, which are critical for rearing Coho salmon. The USGS simulation of climate change in the Santa Cruz Mountains (Flint, L.E., and A.L. Flint, 2012) concludes that the range of redwoods will be greatly reduced due to the effects of climatic water deficit (see Section 5.13.2).
- *Maritime Chaparral:* Several endemic species of Manzanita, including Ohlone Manzanita (*Arctostaphylos ohloneana*), silverleaf Manzanita (*A. silvicola*), and Santa Cruz Manzanita (*A. andersonii*), are found only within reach of the summer fog. The maritime chaparral communities they dominate also support other plants and diverse animal assemblages.
- *Coastal Prairie:* Floristically rich coastal prairie grasslands occur within reach of the coastal fog, which some species utilize for moisture in the summer (Corbin et al., 2005).

The predictions for future summer fog frequency on California's coast are unclear. While a 33 percent reduction in the frequency of California summer fog has been observed over the past century (Johnstone and Dawson 2010), the predicted increase in temperature differential between coastal and inland areas, which is a major driver of fog, may increase the frequency of summer fog thus mitigating the effects of global change on temperatures in Santa Cruz County. Monitoring will be needed to inform future conservation and management.

Table 5-4: Species and Biological Systems that Could be Most Vulnerable to the Impacts of Climate Change

Criteria	Terrestrial	Aquatic
Specialized Habitat or Microhabitat	• Santa Cruz sandhills endemic species (e.g. Zayante band-winged grasshopper) • Karst cave and cavern endemic species • Coastal dune, wetland, and rock outcrop species including many shorebirds. • Soda Lake alkali plant community • Coastal prairie grassland species • Marbled Murrelet and other redwood forest-obligate species. • Pine Siskin and other Monterey pine species.	• Marsh and other wetland species, including many plants, amphibians, reptiles, and birds (resident and migrants). • Pond-breeding species including Santa Cruz long-toed salamander, California red-legged frog, and western pond turtle. • Tidewater goby and other lagoon species. • California brackish water snail.
Narrow environmental tolerances that are likely to be exceeded.	• Monterey Pine and coast redwood, which require cool, foggy areas. • Maritime chaparral endemic species (e.g. *Arctostaphylos ohloneana*) which require fog. • Black oak and foothill pine, which are at the edge of their elevational range.	• Coho salmon. • Species at the southern end of their range including Pacific giant salamander and rough-skinned newt.
Dependence on specific environmental triggers or cues that are likely to be disrupted.	• Breeding birds. • Migratory species (butterflies, birds, and bats).	• Fish sensitive to the timing of lagoon closures and openings due to precipitation (e.g. steelhead and Coho). • Breeding amphibians, which require specific pond hydroperiods.
Dependence on interspecific interactions that are likely to be disrupted.	• Insect-pollinated plants, especially those with specialist pollinators. • Insectivorous bats, especially specialist (e.g. pallid bats feed largely on Jerusalem crickets).	• Increased stream biological productivity due to higher temperatures could alter competitive relationship in stream assemblages.
Poor ability to colonize new, more suitable locations.	• Many plants. • Limited mobility animals including flightless insects.	• Pond invertebrates, amphibians, and reptiles that cannot disperse through upland habitats, particularly developed areas.

Source: Mackenzie, A, J. McGraw, and M. Freeman. 2011.

More frequent fire predicted to accompany the hotter, drier climate will likely alter dramatically the structure and species composition of the natural communities within Santa Cruz County (Fried et al. 2004). Across the Central Coast Ecoregion, the extent of shrublands and conifer forests are predicted to decline while the area of grassland increases (Lenihan et. al. 2008). These predictions suggest that maritime chaparral, sandhills, and coastal scrub as well as coast redwood and Pacific Douglas fir forests could decline while more arid grasslands could expand in Santa Cruz County. More research is needed to understand the implications of these regional changes for the species and communities of Santa Cruz County.

5.10.2 Sea Level Effects on Biodiversity

Sea level has risen by nearly eight inches in the past century, and may rise by more than 5.5 feet (16.5–65.7 inches) by the end of this century (National Research Council, 2012). The resulting inundation and attendant erosion and flooding could eliminate coastal habitats, including:

- *Rock Outcroppings* used for roosting and nesting by coastal seabirds, such as double-crested Cormorants, Brown Pelicans, and Pigeon Guillemots, and as haul-out sites for marine mammals including harbor seals;

- *Coastal Wetlands* including salt marsh and brackish marsh, which support a diverse assemblage of shorebirds including Black-Necked Stilt and American Avocet;
- *Bluffs* utilized by nesting birds including Black Swifts, unique plant assemblages featuring succulents (*Dudleya* spp.); and
- *Dunes* utilized by many plant and animal species including nesting Western Snowy Plovers, Monterey spineflower, and globose dune beetles.

While new habitats could be created adjacent to the areas that will be inundated, this will not be possible where the adjacent land is already developed or is armored (e.g. by sea walls or levees). A state-wide analysis found that only 40 percent of the area in Santa Cruz County is suitable for wetland migration (the formation of new wetlands). Protecting this land will be key to mitigating loss due to sea level rise (Mackenzie, A, J. McGraw, and M. Freeman. 2011).

5.10.3 Climate Change Resiliency

There are several ways that the ability of natural systems to persist, or retain the same basic structure and functions, in the face of climate change can be enhanced:

- Protect land featuring a diverse range of geophysical conditions including topographical conditions, soils, slope-aspects, elevations, and localized climates.
- Protect heterogeneous habitats including a range of successional stages (i.e., time since last fire or other disturbance).
- Protect climate change refugia–areas that may buffer species against climate change.
- Protect buffers around key habitat areas where migration is feasible.
- Ensure long-term viability through redundancy: protect areas of each community, habitat, or refuge across the landscape.
- Preserve landscape connectivity by maintaining permeability and protecting critical linkages.
- Monitor climate change and its impacts and adapt conservation strategies to address changing circumstances.

One very effective approach would be to conserve areas that can buffer species from the impacts of a hotter and drier climate change (see Table 5-5). These climate change refugia include areas that are wetter and cooler at present. These areas are generally scattered throughout the county. Wet areas will also be critical to human adaptation to climate change. Protecting intact habitat where wetlands can migrate is another way to add resiliency (Mackenzie, A, J. McGraw, and M. Freeman. 2011).

5.11 Impacts to Water Supply

Water supply consists of the water resources available for agricultural irrigation and production, drinking water, residential use, landscaping, cooling, and power generation. In California, water resources originate in the form of rain or snowfall and are predominantly spread among the Sierra snowpack, the state's water network (including streams, rivers, aqueducts, and reservoirs), and groundwater. Along with the growing population and the health of ecosystems, climate change is one of the major influences on the availability of water resources (State of California 2012a).

The effects of climate change on water supplies will have impacts on agriculture, recreation and tourism, and the economy overall as well as on natural ecosystems. The environment (that is, the water needed to maintain ecosystems) accounts for 48 percent of water use in California, with agricultural use at 41 percent and urban use at 11 percent (Agricultural Issues Center, 2009). Due to projected population growth, however, urban use is expected to increase more than 50 percent by the year 2050 (Kahrl and Roland-Holst, 2008).

Table 5-5: Potential Climate Change Refugia in Santa Cruz County		
Refugia	**Contribution to Climate Resiliency**	**Occurrence in Santa Cruz County**
Coastal Areas	• The ocean buffers temperature increases. • Fog can further ameliorate climate change.	• Approximately 40 miles of coastline; most of the county is within 15 miles of the coast. • Long, coastal valleys convey cooler air inland.
Streams and Riparian Areas	• Source of perennial water for animals. • Feature cooler microclimates due to evaporation and transpiration. • Create corridors that can facilitate animal movement in response to climate change.	• 850 miles of streams, 550 miles of which are perennial. • Stream network is pervasive and collectively connects much of the county. • Some streams, particularly in the Pajaro Valley, are highly degraded.
Ponds, Lakes, Sloughs, and Reservoirs	• Source of water for animals. • Feature cooler microclimates due to evaporation and transpiration.	• At least 90 water bodies totaling more than 1,500 acres. • Most features are in the Pajaro Valley.
Seeps and Springs	• Source of perennial water.	• 20 mapped seeps and springs (USGS), though likely many more occur in the landscape.
North-facing Slopes	• Cooler microclimate due to reduced solar insolation and typically greater vegetation cover and thus evapotranspiration.	• More than 36,000 acres of north-facing slopes (aspects of 340 to 20 degrees), scattered throughout the county. • Variable, mountainous topography results in north-facing slopes being well-distributed within the county.
Steep Elevation Gradients	• Reduce the distance species need to move along an elevation gradient. • Precipitation and winter minimum temperature increase with elevation, though so does summer maximum temperature in Santa Cruz County.	• Elevation ranges from sea level to approximately 3,400 feet. • Steep terrain occurs within contiguous habitat patches on Ben Lomond Mountain (which receives high precipitation) and near Mount Umunhum and Loma Prieta.
Source: Mackenzie, A, J. McGraw, and M. Freeman. 2011.		

Climate change threatens several aspects of a community's water supply. It can affect the source of a community's water (e.g., precipitation and groundwater recharge, etc.) as well as a community's use behavior. The USGS projects increasing drought and decreased groundwater recharge (Flint, L.E., and A.L. Flint, 2012). For coastal areas of Santa Cruz County, sea level rise can threaten groundwater resources due to sea water intrusion.

A drought is a period of dry weather that persists long enough to cause serious problems such as crop damage and/or water supply shortages. Droughts may not be predictable, but they should be expected. They occur with some regularity and varying levels of severity. The magnitude and duration of a drought is something that can be predicted based on historical records and should be taken into account in water resources planning. In recent history, Santa Cruz County experienced three drought periods: 1976-77, 1987-1992, and most recently in 2007-09. It is expected that the effects of climate change will result in more severe droughts of longer duration.

Water supply in Santa Cruz County is provided by a number of independent water agencies, as shown in Table 5-6 below. Fifty-seven percent of the County population is served by the two largest jurisdictions, the cities of Santa Cruz and Watsonville, with substantial parts of their service areas outside of the city limits. Thirty-seven percent of the Santa Cruz customers (32,500 people) and 20 percent of the Watsonville customers (12,000 people) are outside the city limits. Almost all of the jurisdictions are experiencing some kind of water supply shortfall from overdraft of the groundwater basin, inadequate supply during a drought, or inadequate facilities to meet current demands. Forty-six percent of County population is served by water agencies that get more than 50 percent of their supply from surface water. It is those sources that are most susceptible to drought.

The County of Santa Cruz Department of Environmental Health Services (EHS) is preparing an Integrated Regional Water Management Plan (IRWMP). A chapter of the IRWMP will feature a discussion of the potential effects of climate change on the Santa Cruz water planning region, including an evaluation of vulnerabilities to the

effects of climate change and potential adaptation responses to those vulnerabilities. This analysis will be informed by work conducted by the United States Geological Survey (USGS) Pacific Coastal and Marine Science Center, which assessed potential hydrologic changes in the watersheds such as rainfall, runoff, recharge, soil moisture, base flow, and groundwater conditions. In addition to the USGS work, EHS is working on an analysis of potential climate change impacts from sea level rise and increased ocean energy on water resources infrastructure and natural resources. The IRWMP will use the USGS work along with the coastal vulnerability analysis to apply a risk matrix that evaluates the likelihood of impacts occurring in the future and the magnitude of the potential consequences. The risk matrix will be used to identify priority adaptation strategies. A Draft of the IRWMP is expected to be completed in mid 2013.

Table 5-6: Water Suppliers within Santa Cruz County

Water Supplier	Connections	Population	Water use (acre-feet/yr)	Ground	Surface	Current Shortfall
Santa Cruz City Water Dept.	25,000	95,000	11,800	4%	96%	Drought
Watsonville City Water Dept.	15,000	63,700	9,300	89%	11%	Overdraft
Soquel Creek Water District	15,000	49,000	5,400	100%	0	Overdraft
San Lorenzo Valley (SLVWD) Northern	5,300	16,500	1,500	40%	60%	Drought
SLVWD Southern	785	2,500	400	100%	0	Overdraft
SLVWD Felton	1,300	4,000	455	0	100%	Drought
Scotts Valley Water District	3,600	11,300	1,700	100%	0	Overdraft
Central Water District	800	2,700	600	100%	0	OK
Lompico Creek Water District	500	1,300	70	20%	80%	Drought
Big Basin Water Company	580	1,500	240	15%	85%	?
Mount Hermon Association	530	1,400	250	100%	0	Overdraft
Forest Lakes Mutual Water Company	330	900	140	100%	0	Facilities
130 Smaller Water Systems (5-199 connections)*	5,000	14,000	3,500	95%	5%	OK
Individual Users*	8,000	20,800	6,000	95%	5%	OK
Pajaro Agriculture	n/a	n/a	48,000	100%	0	Overdraft
Total	**81,725**	**284,600**	**89,355**	**--**	**--**	**--**

Note: *Values are estimated
Source: County of Santa Cruz Local Hazard Mitigation Plan, 2010.

5.12 Impacts to Public Health

Much of the available information has been generated by the Center for Disease Control and Prevention (CDC) and the California Department of Public Health (CDPH). In Santa Cruz County the predicted health effects of climate change include increased incidence of emerging diseases and vector-borne disease if ecological changes lead to migration of insect and animal disease vectors, and physical and mental health impacts associated with severe weather events, such as flooding, when they cause population dislocation and infrastructure loss. Though extreme heat may be moderated in our coastal location, inland areas of the County can experience much higher temperatures. An increase in temperature can exacerbate existing respiratory disease, cardiovascular disease and stroke. Wildfires are also expected to increase in frequency and severity as drought takes hold, which may cause respiratory distress, exacerbation of existing disease, physical and mental dislocation, as well as some number of direct fatalities.

Further, geographic, racial, and income disparities make some segments of the population more vulnerable to health impacts than others (California Department of Public Health 2012). Adapting to these conditions may include identifying the most vulnerable populations in the County in order to emphasize adaptation strategies that are appropriate for those populations. Building and Fire codes that address wildfire, emergency response plans

for wildfire, and the various plans that are in place for responding to infectious disease, should be assessed for opportunities to strengthen prevention and emergency response.

The Mosquito and Vector Control (MAVC) program, County Service Area 53, is an existing resource for controlling the incidence of vector-borne and zoonotic disease. As a County Service Area administered as a division under the Agricultural Commissioner, the MAVC is responsible for public health pest control. To meet these challenges the County Board of Supervisors and cities have authorized the MAVC to put landowner and resident-approved funding mechanisms in place to conduct surveillance, education and biorational integrated control strategies to reduce mosquitoes and other vectors.

5.13 Economic Impacts of Climate Change

Santa Cruz County has many industries; however, agriculture, tourism, forestry, and commercial fishing may suffer significantly from climate change. Partnerships should be formed with businesses in these four industries to determine how to build flexibility into businesses in order to minimize economic disruption. Disruption planning must address the requirements of these industries for reliable transportation systems and other assistance.

5.13.1 Agriculture

Agriculture is a major portion of economic activity in Santa Cruz County. Agriculture will be affected by projected changes in weather, precipitation, water supply, and sea level rise.

Specifically, the projected increase in climatic water deficit and reduction in aquifer recharge adds to longstanding concerns about adequate water supply for irrigation. Refer to sections 5.7.1 and 5.7.2 for a discussion of changing precipitation patterns and climatic water deficit. Adapting to the potential for decreased water for irrigation will likely involve elements of increased conservation of water, continued effort to reduce sea water intrusion, water supply development where feasible and environmentally sustainable, and the industry positioning itself to be flexible with cropping pattern and farming practices. Flexibility in the industry will also be necessary to adapt pest management practices as climate change affects the timing and type of threats from agricultural pests. Sea level rise may exacerbate difficulties on coastal farms where soil is becoming compromised by brackish water overflowing from coastal sloughs and drainages.

5.13.2 Forestry

Forests occupy much of the unincorporated land area in Santa Cruz County. As noted in the emissions inventory, the County has approximately 143,000 acres of redwood and redwood-Douglas-fir forest and 19,900 acres of oak woodland (Mackenzie, A., J. McGraw, and M. Freeman, 2011). Potential alterations to temperature, precipitation regime and fog dynamics from climate change will influence tree survival and growth, forest composition, forest health and productivity. At the same time the intensity of ecosystem disturbances from wildfire, insects, and pathogens is likely to increase. `

By using a long-term index of daily maximum land temperatures, Johnstone and Dawson (2010) infer a 33 percent reduction in fog frequency since the early 20th century. Tree physiological data suggests that coast redwood and other ecosystems along the United States west coast may be increasingly drought stressed under a summer climate of reduced fog frequency and greater evaporative demand. Since 1901, the average number of hours of fog along the coast in summer has dropped from 56 percent to 42 percent, which is a loss of about three hours per day. This trend is expected to continue into the future as a result of climate change.

A study completed in 2012 by the USGS for the County of Santa Cruz concluded that redwood forests currently living at the edge of their suitable range are most at risk, and in the Santa Cruz Mountains the population may be largely reduced to populations located on north and northeast facing slopes.(Flint, L.E., and Flint, A.L., 2012).

A comprehensive and integrated study of climate impacts on coastal redwoods is being conducted in partnership with researchers from the University of California, Berkeley, Humboldt State University and the California Academy of Sciences. One important aspect of the initiative is to use a wide range of global climate model outputs to examine the potential future distribution of coastal redwoods. Once finalized, the range shift projections will be used to prioritize land acquisitions for conservation, and to disseminate information to key decision-makers (Save the Redwoods League, 2012).

The researchers examined the entire 450-mile native range of the coastal redwood, most of which is now covered with second and third growth forests. Although the study is not yet completed, several important patterns have emerged:

- The southernmost part of the current range of coastal redwood is in jeopardy of not being able to maintain redwoods into the future (see Figure 5-16).
- Suitable habitat for coastal redwood may expand into the southern and central coast of Oregon by mid-century.
- There is a large difference in the amount of suitable habitat under different greenhouse gas emission scenarios. Under a scenario involving major global shifts to renewable energy sources (the "B1" scenario), much of the existing habitat for coastal redwoods would likely persist into the future. Under a more business-as-usual scenario of continued high global emissions (the "A2" scenario), the suitable habitat for coastal redwoods is dramatically reduced. Current research reveals that the A2 scenario assumptions are being exceeded. See Appendix E for a description of IPCC Global Emissions Scenarios.
- Under either scenario, there are 'climate refuges' for coast redwood that overlap with existing important protected areas. These regions of persistence may become high priority targets areas to expand protection and manage for connectivity to other protected areas (Data Basin 2012)

Figure 5-16: *The Anticipated Impact of Climate Change on the Future Distribution of Coast Redwood Forests*
Under an "optimistic" outcome, in which CO_2 levels in the atmosphere remain relatively low, much of the current coast redwood habitat remains. Under a "pessimistic" outcome, in which we continue emitting greenhouse gases at the current rate, much of the current habitat for coast redwoods is no longer suitable. In addition to informing strategies for conservation planning, these results demonstrate that reductions of emissions today will affect the future survival of coast redwoods.
Source: Data Basin 2012

Changes in temperature, precipitation, coastal fog, and wildfire risk will change forest productivity (see preceding discussions in Chapter 5 for a complete discussion of these vulnerabilities). Consequences for the forestry industry are likely to be slower growth, stressed trees, or insect epidemic. Some forests are at greater risk of

stand-replacement wildfires that damage or destroy long-term investment while requiring post-fire planting, road maintenance, and other actions (State of California 2012b). Santa Cruz County is located at the southern extent of the current range of coast redwood. This is the area of the range that is at greatest risk of disappearing.

5.13.3 Tourism

California has the nation's largest ocean economy, valued at about $47 billion/year, with the great majority of this connected to coastal recreation and tourism as well as shipping and ports. Many of the facilities and much of the infrastructure that support these industries, as well as the state's many miles of public beaches, are within just a few feet of present sea level (California Energy Commission, 2012). Tourism ranks, alongside agriculture, as one of the top employers and revenue-producing industries in Santa Cruz County, generating over $500 million in direct travel expenditures annually. Tourism also generates over $14 million in taxes for local government, which helps to pay for police and fire protection, road repairs, park maintenance and social services (source: Santa Cruz County Conference and Visitors Council, 2012).

Tourism in Santa Cruz depends on beaches, coastal recreation, and on attractions that are close to the ocean. Rising sea level threatens the beaches with increased erosion, severe storms and flooding that can damage infrastructure, access, and tourist attractions. Several key roads and bridges are at low elevation and close to the coast where they are vulnerable to flooding, storm waves and erosion.

It is typical that triple-digit temperatures in the interior areas of California draw visitors to the Santa Cruz area. Several million people live within a few hours drive from Santa Cruz. Much of the County's local commerce depends on those daily and weekly summer visitors drawn in part by cooler coastal temperatures. This attraction could increase as summer temperatures grow in surrounding inland areas. In this sense, climate change presents an economic opportunity for Santa Cruz County, but this is balanced against costs to protect infrastructure and potential loss of redwood habitat (refer to section 5.13.2), beaches and other natural resources that attract visitors.

5.14 Climate Change and Social Vulnerability

Social vulnerability is defined as "the intersection of the exposure, sensitivity and adaptive capacity of a person or group of people" to climate change (Pacific Institute, 2010). In the social vulnerability literature, data are used to assess the people most at risk to climate change due to a combination of their social and demographic characteristics (e.g., economic status, age, and ethnicity), level of exposure to impacts likely to occur, sensitivity to impacts (e.g., health condition, occupation), and adaptive capacity (e.g., networks, knowledge, attitudes) (Wongbusarakum and Loper, 2011; Cutter et al., 2009).

To compare overall social vulnerability to climate change among areas within California, a single vulnerability index that combines data from 19 vulnerability factors was used by the Pacific Institute (2012) to calculate a vulnerability index for each of the 7,049 census tracts in the state. A higher score indicated the population within a tract had greater social vulnerability to climate-related disturbances. According to the study, approximately 50 percent (125,000) of the population of Santa Cruz County would have low social vulnerability to the effects of climate change, while 27 percent (66,700) would have medium social vulnerability, and approximately 24 percent (59,900) would have high vulnerability to climate change. Four factors (lacking a high-school diploma, low-income, non-English speaking, and people of color) were the primary drivers for the most vulnerable census tracts that were analyzed statewide (Pacific Institute, 2012). Other factors in order of high to low vulnerability included the following: foreign born, overweight, renters, no vehicle, pre-term births, under-18 population, impervious land cover, unemployment, outdoor workers, pregnant women, lack of tree canopy, no air conditioning, food deserts, institutionalized population, and population over 65 living alone.

Climate risk is a function of exposure and vulnerability. Vulnerability index score maps were overlaid with maps of projected exposure to extreme heat, particulate matter, coastal flooding, and wildfire to identify areas with high social vulnerability and high projected exposure to climate change disturbances. The areas of overlap indicated those locations with heightened risk of being impacted by these climate changes as a result of exposure and social vulnerability. Geographically, the majority of Santa Cruz County would experience low social vulnerability. However, the extreme southeast area of the County would likely experience medium and high social vulnerability, while areas of the City of Santa Cruz may experience medium social vulnerability (Pacific Institute 2012).

5.14.1 Extreme Heat

Climate change is projected to increase the frequency and intensity of extreme heat events. Areas with historically moderate temperatures such as Santa Cruz County may have unexpected heat spells, and areas that already have intense heat may have more extreme, longer and/or more frequent periods of heat. Inland areas of Santa Cruz County such as the San Lorenzo Valley, the Summit, and Eureka Canyon can experience much higher temperatures than coastal areas. Extreme heat events can lead to heat-related illness and death, particularly for the elderly.

In a recent social vulnerability study by the Pacific Institute (2012), the magnitude of extreme heat was measured in terms of the number of days that the daily maximum temperature exceeds the 95th percentile historical (1971-2000) local high-heat threshold during the summer months (May 1 through October 31). By definition, the 95th percentile high-heat threshold is the local temperature exceeded 7.6 days per year, on average, over the summer months during the historical period (1971-2000). The 95th percentile temperature fell within 80°–90°F in many of the coastal and northern counties, and for comparison, reached over 100 degrees in much of the Central Valley and southern California.

Climate change within this 1971 to 2000 time period increased the number of extreme heat events across the state. The largest increases in the number of days exceeding the local high heat threshold were in the inland and southern parts of California. For example, in Inyo County, the number of days exceeding the local high heat threshold (101°F) increased from 7.6 days under historic conditions to 40 days under the low emissions (B1) scenario and 71 days under the medium emissions (A2) scenario by 2070–2099. The coast experienced considerably smaller increases. . Santa Cruz County's average 95th percentile daily maximum temperature from May 1 to October 31 over the historical period (1971-2000) is 87.1°F under the B1 scenario and 87.3°F under the A2 scenario (2070–2099). The number of days exceeding the local high heat threshold (87.1°F) increased from 7.6 days under historic conditions to 21 days under the B1 scenario and 34 days under the A2 scenario by 2070–2099. Refer to Appendix E for a description of IPCC Global Emissions Scenarios A2 and B1.

Exposure to extreme heat was much greater under the A2 scenario than under the B1 scenario. By the end of the century, 28 million Californians, about 76 percent of the population, would face more than 38 days of temperatures that currently occur on the hottest 7.6 days of the year. Of those with high exposure to extreme heat, about 37 percent, or 10.1 million people, also live in areas of high social vulnerability. For Santa Cruz County, under the B1 scenario, no one of high social vulnerability would be affected. However, under the A2 scenario (2070–2099), some 25,800 socially vulnerable people could be affected by exposure to increased heat. Of those affected, 21,820 would be of low social vulnerability and the remaining 4,010 would be of medium vulnerability (Pacific Institute, 2012). It should be noted that extreme heat events are less likely to occur in the Central Coast Region than in California's inland valleys. When they do occur, however, vulnerable populations may be severely affected because of a historic lack of adaptive capacity to historically milder temperatures (State of California, 2012a).

5.14.2 Coastal Flooding

Under the B1 scenario (see Appendix E), with 39 inches rise in sea level, nearly 420,000 people in California are expected to be exposed to coastal flood risk by the end of the century. Under the A2 scenario, with 55 inches of rise in sea levels, more than 480,000 people along the California coast are expected to be exposed to coastal flood risk by the end of the century. Under both A2 and B1 scenarios, about 18 percent of those exposed to coastal flooding live in areas with high social vulnerability. San Mateo County has a large number of people living in areas with high social vulnerability, as does Marin, Monterey, Orange, and Ventura counties. About 43 percent of those exposed to flooding from sea level rise live in areas with a medium social vulnerability. The remainder of people live in areas with low social vulnerability (Pacific Institute, 2012).

In Santa Cruz County under the B1 scenario, over 14,000 people live in census tracts expected to be exposed to coastal flood risk by the end of the century. Under the A2 scenario, 16,000 people live in census tracts that are expected to be exposed. The greatest number of people exposed for both scenarios live in areas with medium social vulnerability. (Pacific Institute, 2012).

5.14.3 Wildland Fire

According to the California Climate Change Adaptation Policy Guide (State of California, 2012), a low to moderate change in wildland fire risk is projected for the Central Coast Region. Cal-Adapt projections also suggest that Santa Cruz County would have a low to moderate change in projected fire risk (State of California 2012a). All of those people living in areas with a high change in wildland fire risk are located in southern California. Climate change is not anticipated to substantially change the current risk of wildfire under either the B1 or A2 climate change scenarios.

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6.0 Risk Assessment

Adaptation to climate change is fundamentally a risk management strategy, or an insurance policy against an uncertain future. Risk is a combination of the likelihood of any of the previously described climate related events occurring in the future, and the magnitude of the potential consequences. Some processes or events, several years of drought, for example, have occurred often in the past and have a very high probability of occurring in the future, probably more frequently. The consequences of a prolonged drought can be very significant. The product of the probability and consequences of drought and the associated water shortages, therefore, produce a very high risk rating, over both the short and long-term.

The consequences of any particular event may be economic, social, or environmental. A general qualitative assessment of risks has been included in this section, but no attempt has been made to assess specific types of consequences. Additionally, risks for each of the climate-related events that the County of Santa Cruz is expected to face are evaluated for both a short to intermediate time frame (2010-2050), and an intermediate to long-term time frame (2050-2100). Three different levels of Magnitude: Low, Moderate and High, have been chosen, and four different levels of Probability or Likelihood of Occurrence: Low, Moderate, High and Very High.

Processes such as floods and droughts reflect climate variations or fluctuations. The County has adequate records for these types of events, simply because the County has experienced these types of events many times throughout its history. As a result, there is a high degree of certainty that both floods and droughts will occur in the future. The uncertainty lies in how much more frequent and how much more severe these events will be in the future as a result of changing climate.

There are other events related to climate change, those related to sea level rise for example (inundation of low lying coastal areas, a rise in the water table beneath Rio Del Mar Esplanade/Flats), where the future unknowns are higher, simply because of the lack of certainty about future greenhouse gas emissions and how they will influence climate and sea level rise. Despite the uncertainties, it is possible to make some judgment as to the relative level of risk that each of these poses to the County based on some range of future projections. Based on the trends of the past century and the various climate models that have been developed, the risks from each of these climate-related events will almost certainly increase in the future (Figure 6-1).

Over the next 40 years (between 2010 and 2050), it is expected that the highest risks to the County of Santa Cruz will come from:

- Potential water shortages due to the combination of increasing temperatures, changes in precipitation patterns increasing climatic water deficit, increased salt water intrusion, decreased groundwater recharge, and higher demand. This has a very high probability of occurrence and also significant (high) consequences.
- Rising water table beneath the Rio Del Mar Esplanade is already an issue. As sea level continues to rise, the present problems will be exacerbated. The consequence of a continuing water table rise on commercial and residential structures and infrastructure, including the wastewater pump station is high, and the likelihood of this taking place in the immediate future is high.
- Potential increase in future coastal storm frequency and/or intensity will increase cliff retreat rates as well as cause potential damage to oceanfront property or public infrastructure. The coastlines of northern California, Oregon and Washington have experienced increasingly intense winter storms and greater wave heights over the last 25 years, both of which may be leading to more severe winter erosion (Allan and Komar, 2000). The consequence of coastal bluff erosion is high due to the extent of high-value public and private improvements (infrastructure, structures, etc.).

Figure 6-1. Short to Intermediate Term Risk Ranking 2010-2050

(Risk = Probability x Consequence)

Magnitude of Consequence	Low	Moderate	High	Very High
High	• Increased Wildfires	• Increased Wave Run-up & Storm Surge • Increased Threat to Biotic Resources	• Increased Saltwater Intrusion • Rising Water Table • Coastal Bluff Erosion • Gradual Permanent Shoreline Inundation from Sea Level Rise • Increased Flooding • Increased Landslides	• Water Shortages
Moderate				
Low			• Increased Heat Waves	

Likelihood of Occurrence (Probability)

Legend				
Recommended Action Based on Level of Risk	*No Action*	*Monitor*	*Evaluate Further/ Develop Strategies*	*Develop Strategies*

- Flooding in Santa Cruz County has occurred in each of the primary drainages and will continue to occur in the future given certain sets of meteorological conditions. Previous occurrences are well documented for all primary drainages with the exception of Aptos Creek, which is not gauged. In addition, low-lying areas such as Rio Del Mar Esplanade/Flats will experience more frequent flooding and inundation from sea level rise and increased wave heights. As a result, the consequence would be high in terms of structural and economic loss, with the probability of such an event occurring also being high.
- Groundwater extraction rates from the Pajaro River Valley groundwater basin have exceeded sustainable pumping rates for decades, causing groundwater levels to drop significantly, resulting in saltwater intrusion and rendering some coastal groundwater wells unsuitable for use. With the rise in sea level in the coming decades, saltwater intrusion will be exacerbated. The probability of saltwater intrusion is high due to the current groundwater overdraft situation in the Pajaro Valley, and the consequence of this occurring is high due to the economic effects of fallowing large expanses of farmland to reduce groundwater pumping. However, efforts are being developed to reduce groundwater pumping and to stop saltwater intrusion. The success of these efforts will be challenged by the additional effects of climate change.

  Many of the wells located within the boundaries of the Soquel Creek Water District are also threatened with saltwater intrusion. A reduction in groundwater pumping will be necessary to meet the protective and target water levels necessary to avoid saltwater intrusion into the wells.

- Heat waves in Santa Cruz County are likely to become more frequent in the future due to climate change; however, due to the marine climate, temperature increases would be moderate. As a result, the consequence would be low while the probability of such an event occurring is high.
- Climate change is expected to result in additional risk of increased fire frequency, size, and severity beyond the historic range of natural wildfire variability due to increasing length of the fire season, drier fuels, and decreasing forest health. These changes are being driven by alterations in temperature and precipitation regimes (generally, warmer and drier). As a result, the consequence would be high while the probability of such an event occurring is low.

Over the intermediate- to long-term, 2050-2100, in addition to water shortages and a rise in the water table, it is expected that other climate change related events would increase to high and very high levels of risk within the County (Figure 6-2):

- Potential water shortages, as described for the period 2010-2050, shift from a high probability of occurrence to a very high probability of occurrence as climate change progresses.

Figure 6-2. Intermediate to Long Term Risk Ranking 2050-2100

(Risk = Probability x Consequence)

Magnitude of Consequence	Low	Moderate	High	Very High
High		• Increased Wildfires	• Increased Wave Run-up & Storm Surge • Increased Threat to Biotic Resources	• Increased Saltwater Intrusion • Water Shortages • Rising Water Table • Coastal Bluff Erosion • Gradual Permanent Shoreline Inundation from Seal Level Rise • Increased Flooding • Increased Landslides
Moderate				
Low				• Increased Heat Waves

Likelihood of Occurrence (Probability)

Legend				
Recommended Action Based on Level of Risk	*No Action*	*Monitor*	*Evaluate Further/ Develop Strategies*	*Develop Strategies*

- Even though many of the areas of highest vulnerability have already been armored with riprap or seawalls, coastal cliff erosion continues to take place. The value of property and infrastructure in this area is very high, and in the long-term, with a rising sea level and increased winter wave attack, this risk is expected to increase to a very high level.

- Rise in the water table beneath the Rio Del Mar Esplanade as described for the period 2010-2050 shifts from a high probability of occurrence to a very high probability of occurrence as sea level rise progresses.
- Shoreline inundation would affect a number of developed areas along the County shoreline, particularly at the maximum projected sea level values for 2050-2100. The potential for flooding of the Rio Del Mar Esplanade and Beach Drive, for example, has a very high probability of occurring with a high consequence if it were to happen. If winter precipitation increases in the longer-term future, although it is not clear from the models that have been run to date that this will occur, the probability will increase, raising the risk of flooding.
- Flooding, as described for the period 2010-2050, shifts from a high probability of occurrence to a very high probability of occurrence as climate change progresses
- Salt water intrusion of groundwater as described for the period 2010-2050 would continue as sea level rise progresses. The probability of saltwater intrusion increases to very high, and the consequence is very high due to the economic effects of fallowing large expanses of farmland to reduce groundwater pumping. Efforts are underway to reduce groundwater pumping to stop saltwater intrusion; however, the success of these efforts will be challenged by the additional effects of climate change.
- Heat waves as described for the period 2010-2050 shift from a high probability of occurrence to a very high probability of occurrence as climate change progresses.
- Climate change is expected to continue to contribute to increased wildfires as described for the period 2010-2050 with the probability of occurrence shifting from low to moderate as climate change progresses.

7.0 Climate Adaptation Strategy

Adaptation efforts in Santa Cruz County by government and other organizations already exist in the form of emergency preparedness plans, public health programs, water supply contingency plans, flood regulations, sustainable agriculture efforts, and land protection programs. Additional research and planning should build on these existing efforts and amend them to address climate change directly.

7.1 Impediments to Climate Change Adaptation

Despite the substantial economic assets of our nation, our state, and our community, our adaptive capacity to respond to new stresses associated with climate change is limited. As a starting point, it can be argued that our societies are not even well adapted to the existing climate, especially to well-understood natural hazards (earthquakes, hurricanes, floods, and drought) that continue to result in human disasters. Numerous reports and academic research studies describe longstanding impediments to natural hazards mitigation, and these challenges will continue to limit our capacity to adapt to climate change—especially when it involves the intensification of natural hazards (NAS-NRC, 2010).

Adaptation requires both actions to address chronic, gradual, long-term changes such as sea level rise, and actions to address natural hazards that may become more intense or frequent (droughts or floods). Addressing gradual changes is challenging because the eventual extent of such changes is difficult to recognize and measure and costs for initial investments may be considered unaffordable even when they would be cost effective in the long-term.

For several decades, adaptation to climate change has been neglected in the United States, perhaps because it was perceived as secondary in importance to mitigation of climate change (e.g. through greenhouse gas emission reduction), or perhaps more importantly, because it would actually take attention away from mitigation by implying that the country can simply adapt to future changes. In addition, the topic of climate change and the discussion of options for responding have become much more highly politicized in the United States than in some other parts of the world. Arguments in the media over whether climate change is “real” and to what degree it is a problem generated by human activity have confused people about whether action is needed and whether their actions can make any difference. Further, there are frequent suggestions in the media that responding to climate change is “too expensive” or that the options available to limit emissions and adapt to impacts will have a negative impact on the U.S. economy. The emerging reality is that the long-term risks and costs of not responding are likely far greater than the short-term costs of reducing dependence on fossil fuels and transitioning to renewable energy sources. In fact, California has much to gain economically from this transition.

In our society, there are those who see climate change only as a rise in temperature of a few degrees, which they feel is of no concern; those who say that their hands are tied and that they feel powerless to have any impact so why bother; those who are simply tired of hearing about the problems and are suffering issue fatigue; and those who have difficulty dealing with probabilities, and who want perfect information and complete agreement before they are willing to believe in the problem and make change (Moser, 2009).

Adaptations to long-term problems involve long-term investments and also bring considerations of intergenerational equity and other social and economic factors into play that significantly affect the calculation of costs and benefits. The influences of climate change extend well beyond the election cycle of the typical public official in the United States. Therefore, long-term adaptations must hold some promise of short-term reward if they are to be attractive to elected decision-makers.

7.2 Principles for Adaptation

Coastal adaptation strategies fall into three major categories:

- Strategies for existing development, including existing infrastructure and other resources located in potentially vulnerable areas. Strategies for addressing climate change impacts include monitoring of vulnerable property, red-tagging of property in imminent danger, seawalls to protect critical infrastructure, planned retreat, and rebuilding restrictions for vulnerable structures following climate-related disasters.
- Strategies for new development, including mandatory setbacks to restrict development in vulnerable areas, required warning notices to developers and buyers on potential impacts of future climate change, smart growth and clustered development in low-risk areas, designing for climate resiliency, and the development of expendable or movable structures in high-risk areas.
- Strategies to protect and preserve beaches, wetlands, subtidal habitats, and fisheries in the face of climate change include regional sediment management planning to help restore natural sources of coastal sediment, beach nourishment to replace areas lost to sea-level rise or erosion, creation of additional "buffer zones" to allow for wetland migration as the climate changes, creation of new wetlands to replace lost areas, fishery management plans that set catch limits with future climate change in mind, subtidal habitat enhancement, and the creation of Marine Protected Areas.

(Climate Action Team, 2010)

7.3 Adaptive Capacity

For each risk identified for the County, there is typically a set of possible adaptation measures or strategies that could be implemented to reduce the future exposure from the specific risk. For some risks, the County can significantly reduce its vulnerabilities by taking some relatively direct actions; in other words, we have a high adaptive capacity. One good example would be coastal bluff erosion. For other risks, there is very little that can be done to ease or reduce the future impacts, or in other words, we have a low adaptive capacity. Perhaps the best example is the challenge the County will face in dealing with a significant future rise in the ground water table beneath the Rio Del Mar Esplanade. This area of the County was built on flood plain deposits and filled in wetlands of Aptos Creek, which consist primarily of sands and gravels that have a high permeability. As a result the water table is believed to closely reflect the water level in the adjacent creek. As sea level continues to rise, the water level in Aptos Creek will rise at high tides and the ground water table beneath the Rio Del Mar Esplanade/Flats will experience the same rise. This happens now and has for some years but will worsen in the future. There does not appear to be a practical solution or adaptive response; and therefore, the County has a low adaptive capacity.

7.4 County of Santa Cruz Climate Adaptation Goals

Goals are generally guidelines that reflect community values and explain what is to be achieved. They are broad-based, long-term, policy statements that guide future actions and choices as related to achieving the goals. The success of this Climate Adaptation Strategy will be measured by the degree to which the goals are accomplished that yield actual risk reduction. The following goals have been proposed in an effort to guide development of more specific adaptation strategies that would reduce our vulnerability to climate change.

- Protect the unique character, scenic beauty and culture in the natural and built environment from being compromised by climate change impacts.
- Support initiatives, legislation, and actions to respond to climate change.
- Encourage and support actions that reduce risks and vulnerabilities now, while recognizing the importance of identifying, making decisions about, and preparing for impacts and risks that may develop in the future.

- Support the reduction of risks from other environmental hazards, noting the strong interrelationships and benefits between reducing risk from climate change, non-climate change-related disasters, and most other environmental hazards.
- Build resilience into all programs, policies and infrastructure.
- Encourage climate change resilience planning and actions in private companies, institutions, and systems essential to a functioning County of Santa Cruz.
- Encourage community involvement and public-private partnerships to respond to potential climate impacts, particularly for those most vulnerable.
- Ensure that the County of Santa Cruz remains a safe, healthy and attractive place with a high quality of life for its residents, businesses and visitors.

7.5 County of Santa Cruz Local Hazard Mitigation Plan 2010-2015

The purpose of hazard mitigation is to implement and sustain actions that reduce vulnerability and risk from hazards, or reduce the severity of the effects of hazards on people and property. Mitigation actions include both short-term and long-term activities which reduce the impacts of hazards, reduce exposure to hazards, or reduce effects of hazards through various means including preparedness, response and recovery measures. Effective mitigation actions also reduce the adverse impacts and cost of future disasters.

The County of Santa Cruz developed the Local Hazard Mitigation Plan (LHMP) to create a safer community. The County of Santa Cruz LHMP represents the County's commitment to reduce risks from natural and other hazards, and serves as a guide for decision-makers as they commit resources to reducing the effects of potential hazards. The County of Santa Cruz LHMP serves as a basis for the California Emergency Management Agency (Cal EMA) to provide technical assistance and to prioritize project funding (Code of Federal Regulations (CFR) §201.6.). Many of the strategies outlined in the following section reference strategies already included in the approved LHMP.

In January 2012, the County received a Community Development Block Grant - Disaster Recovery Initiative grant to complete a number of planning activities identified as priority actions in the County's LHMP. One of the actions is an update of the Safety Element of the County General Plan and Local Coastal Program. The update will add policies and goals to incorporate climate change mitigation strategies and climate adaptation strategies, and specifically will address sea level rise and tsunami events in the sections on coastal bluffs and beaches, erosion, flood hazards, and fire hazards.

7.6 Climate Change Adaptation Strategies for Santa Cruz County

The following table presents a set of possible adaptation actions, or strategies, for each of the vulnerabilities and impacts that have been recognized and evaluated. The strategies include a broad range of approaches for protecting people, infrastructure, and natural resources, with an emphasis on building connections among people and organizations. It is important to note that to some extent this discussion is more about protecting the built environment rather than protecting public health and safety. Public health and safety is not the focus because the local, state, and federal agencies have an increasing ability to predict storm events and to notify and evacuate people in advance of hazardous events related to climate change.

Some strategies emphasize future planning, some focus on avoidance of hazards, and others on more specific engineering approaches. Strategies that build partnerships will yield more specific adaptation actions once the cooperative relationships are operating.

In Table 7-1, strategies are paired with one or two climate change impacts as a means of organizing the strategies, but this is a simplification, as most strategies have multiple benefits across subject areas and could be listed as adaptations to several different impacts.

Table 7-1: Possible Climate Change Adaptation Strategies for Santa Cruz County

Climate Change Process	Impact	Possible Adaptation Strategy
1. Continuing and accelerated sea level rise	Gradual Permanent inundation of low lying shoreline areas	Consider designing and siting all future County projects and infrastructure to account for sea level rise projections, considering projected life span of project.
		Develop a detailed priority list for addressing public infrastructure that has been identified as vulnerable, and consider developing retreat or retrofit plans for high priority infrastructure subject to future inundation.
		Consider developing a plan to elevate E. Cliff Drive at Twin Lakes State Beach, Corcoran Lagoon, and Moran Lake to alleviate frequent coastal flooding and potential inundation.
		Develop a forum for ongoing engagement with coastal private property owners and the California Coastal Commission to discuss frameworks for land use policies that respond to expected future losses. Topics would include post-disaster reconstruction, policies regarding engineered protective structures and legal instruments that would allow property owners to acknowledge and accept responsibility for future losses.
		Consider a program to identify areas where high priority wetlands will be inundated, and evaluate options to allow wetland areas to migrate with the shoreline.
		Consider relocating coastal development away from areas that will be inundated to eliminate the risk of damage and the need for coastal protection. This concept is known as “managed retreat” and may only be technically, financially and legally feasible in limited situations.
	Gradual inundation of beaches where back edge of beach is fixed with a structure (beach loss)	Consider limiting new engineered protection structures to infill in locations where the back beach is currently fixed.
		Consider a program to identify those areas where managed retreat should replace engineered protection structures, based on public benefit.
	Rise in groundwater table and channel surge at Rio Del Mar Esplanade backing up in drainage system	Consider securing federal grant funding for the following drainage improvements within the Rio Del Mar Esplanade necessary to protect against a 10-year storm:
		• Construct pump station to include a new concrete vault at the southeast end of the parking lot centerline equipped with multiple pumps and associated control panels; establish new discharge outfall, provide new piping to connect to the existing storm drain systems and install a water quality treatment unit.
		• Install a closed gravity pipe system along Winfield Way that intercepts runoff along the ramped section of Aptos Beach Drive. Install a closed gravity pipe system near the Esplanade frontage that intercepts runoff flowing down the ramped section of Rio Del mar Boulevard.
		• Replace the undersized 12-inch pipes along Aptos Beach Drive with 24-inch diameter PVC, HDPE or RCP piles. Relocate and replace the Esplanade parking lot storm drain system with 18-inch pipes.
		• Rebuild the 12-inch storm drain lateral from the downstream end of the main storm drain up Venetian Road to Lake Court. Provide several

Table 7-1: Possible Climate Change Adaptation Strategies for Santa Cruz County		
Climate Change Process	**Impact**	**Possible Adaptation Strategy**
		inlet locations and a point of connection at Sand Street.
		• Construct a new seawall within the Esplanade parking lot on County property rather than State Parks property. Alignment would likely divide the parking lot into two halves, with the interior side offering year-round use, and the beach side closed in the storm season only.
	Rise in groundwater table at Neary Lagoon Wastewater Treatment Plant	Continue to improve wastewater collection system to reduce infiltration by groundwater or surface water. Monitor groundwater and increase efforts as necessary.
		Consider coordinating with the City of Santa Cruz on programs to minimize vulnerabilities at the Neary Lagoon plant.
2. Sea level rise in combination with winter storms	Increased impacts to residential development from wave run-up, storm surge and flooding.	Develop a forum for ongoing engagement with coastal private property owners and the California Coastal Commission to discuss frameworks for land use policies that respond to expected future losses. Topics would include post-disaster reconstruction, policies regarding engineered protective structures and legal instruments that would allow property owners to acknowledge and accept responsibility for future losses.
		Work with the engineering community to define a standard increment of additional height that should be added to the FEMA 100 year wave run up, storm surge, and flood levels when analyzing hazards in specific locations.
		In consultation with the California Coastal Commission, consider revising regulations that address rebuilding structures that are repeatedly damaged by sea level rise and coastal storms.
		Consider relocating coastal development away from hazardous areas to eliminate the risk of damage and the need for coastal protection. This concept is known as “managed retreat” and may not be technically, financially or legally feasible in many situations.
		Continue implementing and improve the FEMA flood hazard program. See “changing patterns of precipitation” for detailed recommendations.
	Damage to Public infrastructure from storm surge.	Develop a priority list for addressing public infrastructure that has been identified as vulnerable to storm surge and wave run up associated with 16.5–65.7 inches of sea level rise in 2100, and consider developing retreat or retrofit plans for high priority public infrastructure. This list should be updated periodically to reflect new information about the extent and timing of sea level rise.
		Work with the County Office of Emergency Management to refine FEMA flood hazard mapping to account for climate change, as maps are the basis for evacuation notification in the event of anticipated flooding and/or a tsunami.
	Increase in coastal bluff erosion rates	Consider evaluating unprotected developed coastal bluff areas subject to future erosion, and develop plans and timeline for either armor placement, or retreat and relocation of existing public structures and/or infrastructure.
		Consider evaluating areas that are presently armored to determine whether additional armor or managed retreat is the most practical long-term approach.
	Increase in landslides due to magnitude of storm	Continue to require that the County Geologist review development in areas of suspected landsliding and require engineering geology reports when landsliding is identified or suspected.

Table 7-1: Possible Climate Change Adaptation Strategies for Santa Cruz County		
Climate Change Process	**Impact**	**Possible Adaptation Strategy**
	events	Continue to require that an engineering geologist and/or geotechnical engineer investigate the site of any proposed construction near landsliding and require mitigation of landslide hazards before issuing any building or grading permits.
		Continue to require that an engineering geologist and/or a geotechnical engineer investigate any landslide damage to homes or roadways before repair of the landslide and reuse of the homes or roadways.
3. Changing patterns of seasonality of precipitation	Increased frequency and magnitude of winter flooding in response to more concentrated winter rainfall	Continue to work with the U.S. Army Corps of Engineers, County of Monterey, and City of Watsonville to develop a feasible flood control alternative to reduce the potential overtopping of the Pajaro River levees within both Santa Cruz and Monterey counties, including construction of setback levees to reclaim a portion of the floodplain while increasing the flood capacity.
		Amend the Safety Element of the General Plan and revise implementing regulations to increase the efficacy of the damage prevention and flood protection aspects of the National Flood Insurance Program. This would include revising the method of calculating "Substantial Improvement" in the floodplain, maintaining participation in the Community Rating System to improve floodplain management and reduce insurance costs for residents, and creating an online database of elevation certificates (*LHMP)*.
		Consider increasing the freeboard above the projected 100 year flood level that is required for new development, in order to account for sea level rise and increased winter storms.
		Evaluate the effectiveness of current policies and ordinances designed to limit storm water runoff and flooding and, if needed, recommend revisions to improve the effectiveness of these policies and codes. Specifically, evaluate the effectiveness of current drainage plan requirements for new development to ensure that runoff from impervious surface does not contribute to flooding, and revise development permit conditions of approval if needed (*LHMP)*.
		Prepare a "Storm Water Facilities Master Plan" for Flood Control Districts 5 & 6, which includes portions of Live Oak, Soquel, Aptos, Seacliff and Rio Del Mar. This will include an inventory of existing facilities, development of hydraulic and hydrologic modeling of these facilities, development of a prioritized Capital Improvement Program list, hydromodification analysis and development of generic best management practices and design standards (LHMP).
	Reduced water availability due to more frequent drought	Incorporate findings and recommendations of the integrated Regional Water Management Plan (forthcoming) into County water policy.
		Consider implementing additional water conservation programs, regulations and policies to conserve water supplies in the unincorporated area (See also E-8.1, Strategy for Emissions Reduction).
		Support the Pajaro Valley Water Management Agency in continuing efforts to conserve groundwater supplies and mitigate salt water intrusion in the Pajaro Valley.
		Support the development of additional water supplies that meet environmental standards *(LHMP)*.
		Promote more effective use of groundwater storage through increased

Table 7-1: Possible Climate Change Adaptation Strategies for Santa Cruz County		
Climate Change Process	**Impact**	**Possible Adaptation Strategy**
		groundwater recharge and conjunctive use among agencies *(LHMP)*.
		Water supply plans should incorporate potential increases in water demand and reduced availability of supply that is projected as a result of climate change.
		Promote drought planning by 130 small water systems under County jurisdiction (*LHMP).*
4. Higher temperatures and lower rainfall	More intense heat waves (hotter, longer)	Consider developing or updating existing public health plans that address the health needs of chronically ill people and other vulnerable groups during extreme heat events, including designating emergency cooling centers.
		Consider a system for contacting home-bound or disabled residents and moving them to air conditioned shelters as needed.
		Consider updating emergency response plans for limited term and extended power outages.
		Consider planning for a greater influx of visitors to the County from hotter inland regions during extended and more frequent heat-waves.
		Review site design standards for new development, the Urban Forestry Master Plan, and Parks Department plans for public spaces for opportunities to increase tree canopy in the urban area and for continued emphasis on increasing the number of trees in the built environment.
		Encourage efforts by agricultural organizations such as the Santa Cruz County Farm Bureau and the U.C. Agricultural Extension to assist the agricultural sector to identify and adjust to changes in pest management, cropping patterns, water management and other on farm practices that may be required as precipitation and temperature patterns change.
	Increased frequency and magnitude of wildfire	Establish and maintain cooperative fire protection and fire prevention agreements with other agencies *(LHMP)*.
		Work with State and Federal natural resources agencies to standardize environmentally appropriate fuel reduction practices in sensitive habitats.
		Maintain early notification/warning of residents by technology based applications *(LHMP)*.
		Increase visibility and reduce response times with proper road and address markings *(LHMP)*.
		Enhanced support for interoperability communications systems with local, state and federal emergency services both inside and around the County *(LHMP)*.
		Reduce fire risks in the urban/wildland interface (WUI) through improved building materials and appropriate code enforcement including defensible space programs *(LHMP and Calgreen building code)*.
		Implement additional fire prevention education programs, to include school and commercial business *(LHMP)*.
		Develop fuel reduction approaches in all areas, with special approaches

Table 7-1: Possible Climate Change Adaptation Strategies for Santa Cruz County		
Climate Change Process	**Impact**	**Possible Adaptation Strategy**
		for sensitive habitat areas.
	Increased threat to the County's biotic resources, biodiversity and ecological systems.	Consider protecting, and/or assisting non-profit organizations to protect habitat that is essential to facilitating species adaptation to changing climate. This would include protecting potential refuge areas and large, interconnected habitat patches that achieve multiple conservation benefits. Areas to consider include buffer areas around existing protected habitat, areas that facilitate connectivity between populations, representative areas of the County's diverse local climates, and areas that are more likely to be climatically stable or support species in the predicted hotter and drier climate, including streams, ponds, lakes, wetlands, springs, and north-facing slopes.
		Consider revising the Conservation and Open Space element of the General Plan to address the challenges of climate change and to update conservation policies, working with local scientists, conservation and environmental organizations.
		Support private and non-profit organizations efforts to promote community awareness of Santa Cruz County's rich biological systems and their vulnerability to climate change, as well as their role in mitigating climate change, and to track indicators of the effects of climate change on important biological systems.
5. Countywide strategies that address multiple impacts from climate change.	Many existing County policies and programs do not address climate change.	Consider how climate-related goals and strategies can be incorporated into an amendment of the General Plan. This may be coordinated with policies that flow from the Transit Corridors Plan for Sustainable Communities and the Disaster Recovery Initiative funded update of the Safety Element (underway).
		Consider incorporating the topic of developing resiliency in important sectors of the economy (such as agriculture and tourism) into the County economic vitality strategy that is currently being developed.
		Consider a program to identify the key transportation infrastructure, communication infrastructure, utilities, beaches and other amenities that support tourism, agriculture and commercial activity in general, and prioritize them for protection or retrofit.
		Consider adding adaptation to climate change as a specific component of the next update of the LHMP.
Note: *LHMP* indicates this strategy has been adopted as part of the Local Hazard Mitigation Plan. Source: County of Santa Cruz, 2013.		

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Appendix A

List of County Policies and Recent Actions to Reduce Greenhouse Gas Emissions and Improve Resilience

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List of County Policies and Recent Actions to Reduce Greenhouse Gas Emissions and Improve Resilience

County Policies and Procedures for Fleet Management and Energy Efficiency

County Policy and Procedure Manual Section 304

The general objectives of the County's Fuel Efficiency Policy include:

- Reduction of air pollution and excessive gasoline and diesel consumption by vehicles that are not fuel-efficient
- Reduction of taxpayer dollars wasted on gasoline and diesel purchases for vehicles that are not fuel-efficient.
- Reduction of taxpayer dollars that County spends on Sport Utility Vehicles (SUVs) and other inefficient vehicles, where other less expensive vehicles are appropriate.

All newly assigned and replacement vehicle purchases shall be fuel efficient, environmentally friendly "green vehicles" unless otherwise approved by the County Administrative Office. Green vehicles include: electric, hybrid electric/gasoline, flex fuel such as gasoline/ethanol and gasoline/Compressed Natural Gas, Compressed Natural Gas, or any other alternatively fueled and powered vehicle designed to normally operate with zero or minimal environmental impacts.

County Policy and Procedure Manual Section 600

General Policy - On April 25, 1978, the Board of Supervisors adopted Resolution 218-78, which is a policy to support energy conservation and to maintain and operate all County facilities at austere energy levels to conserve fuels and to serve as an example to the public.

General Services Department Responsibility

- To monitor and maintain heating, ventilating and air conditioning equipment at optimum efficiency levels.
- To reduce building lighting to minimum levels based upon area utilization.
- To monitor and discourage the use of non-essential energy consuming appliances and equipment.

Facility User Responsibilities

- Consider energy consumption ratings as an important factor when ordering all equipment for use by their departments.
- Refrain from using any appliances or equipment not essential to the operation of their department.
- Be conscientious in the use of area lighting and operate only those lights, which are absolutely needed to conduct business.
- Turn off all lights and equipment when not in use.
- Operate energy consuming equipment (i.e. cars, trucks, movers, etc.) in a conservative manner.
- Plan field trips ahead to reduce mileage by taking shortest route and to coincide with other activities in area.

General Services Department

The General Services Department (GSD) is the County department with the largest role in energy efficiency in County government.

- Received grant in the amount of $746,372 for Energy Efficiency Conservation Block Grant (EECBG) funding to implement a total of ten projects across six facilities, including HVAC upgrades and ozone laundry systems installation.
- Implemented Air Resources Board grant in the amount of $193,598 for pilot Fleet Management program and expansion of community Zipcar program.
- Applied for California Energy Commission loan in the amount of $130,427 for exterior lighting improvements at various County facilities.
- Continued programs for integrated pest management which support Department of Public Works sustainable roadside vegetation management grant programs, University of California Cooperative Extension alternative herbicide roadside trials, and early stage project review with the former Redevelopment Agency of sustainable landscape practices.
- Installed charging station for electrical vehicles at 701 Ocean Street in anticipation of new technology.
- Began testing small wind and solar generators to serve remote site power requirements.
- Carried out various energy conservation related activities, including upgrades and replacements at various County buildings and facilities: began documentation of warehouse items to be switched to recycled or green certified products, switched to low volatile organic compound (VOC) new or low VOC recycled paint, coatings, surface treatments, lubricants and solvents, and reduced overall volume of products used, extended food waste pick-up to Probation/Juvenile Hall in Felton, switched to recycled/refined oil for vehicles and generators, and continued to promote use of alternative fuel vehicles and of alternative commute solutions, including vanpools, ride-to-work and employee bicycle pool options.
- Completed indoor lighting retrofits at multiple Sheriff locations, Probation, Emeline campus, Freedom and Crestview campus, Rountree, and Main Jail.
- Modify four elevators at Emeline complex (2004-2005).
- Installation of micro turbine generation (2004-2005) Simpkins, and Main Jail.
- HVAC replacement and modernization (2000-2001) South County facilities.
- Ongoing installation of water conserving plumbing, and replacement of windows and refrigeration at various sites.
- Phase 3 701 Ocean HVAC upgrade, Central building cooling plant replacement, Direct digital control building automation system, Cooling tower replacement, Electrical systems expansion and upgrade and cooling system upgrade, Elevator replacement, New electrical transformer, New domestic hot water system, Upgrade Exit signs from florescent to LED.
- Received a grant through MBUAPCD for new bike lockers.
- Received a grant through MBUAPCD for hybrid vehicles for building inspectors.
- Ongoing upgrade of County fleet with fuel efficient and alternative fuel vehicles.
- Installation of CNG fueling system.
- Recognized as a Clean Ocean business (Fleet Operations) for ten years.

Public Works Department

- Continued various efforts to improve landfill diversion rates (recycling, composting, etc.).
- Continued work on various efforts to improve surface water quality (Stormwater Management Plan, sewer overflow prevention, polluted runoff prevention, education/outreach, etc.).
- Continued Integrated Vegetation Management Program to reduce use of pesticides.

- Continued participation in Green Business Program activities and Green Schools Program.
- Supported local Green Building ordinance and polystyrene and single-use bag bans.
- Managed innovative retail take-back programs to divert hazardous wastes including medical sharps, pharmaceuticals, motor oil and fluorescent light bulbs.
- Continued planning for closure of the Buena Vista Landfill and its replacement by the Zero Waste EcoPark.
- Continued to capture methane gas from the Buena Vista landfill and use it to generate renewable electrical energy.
- Participated in pollution prevention/hazmat disposal education programs.
- Continued maintenance and construction on bicycle lanes and pedestrian facilities.
- Installed lighted crosswalks and flashing beacons powered by solar and conventional energy.
- Received a $13,000 Air Quality grant for a vanpool van.
- Used Air Quality grant funds to help establish traffic signal coordination on several major corridors to reduce vehicular emissions.
- Upgraded diesel truck fleet to comply with air quality standards.
- Improvements to water and wastewater pumping and system monitoring equipment to increase energy efficiency.
- Planning for and implementation of energy conservation and recycling improvements at various Parks & Recreation facilities.
- Continued design work for Moran Lake Monarch Butterfly Management Plan.
- Water and energy conservation upgrades at Simpkins Swim Center.
- Stormwater Best Management Practices installation at Anna Jean Cummings Park.
- Working with the County Environmental Health Services on two groundwater recharge projects funded by Proposition 50. Projects include intercepting storm drainage runoff and recharging the groundwater supply at Brommer Park and at the Aptos Polo Grounds.
- Partnered with the California Conservation Corps, the City of Watsonville and County Vector Control to remove invasive aquatic plants (*Ludweiga*) from a portion of Pinto Lake.
- Pursuant to Board of Supervisors direction, formed the County Artificial Turf Committee to research and develop criteria for the use of the turf within the County. The upshot of this research may bring about increased playability of fields and water conservation.
- Utilizes solar power for flashing beacons and lighted cross walks.
- Converted traffic signal lighting to LED.
- Initiated the conversion of street lights to LED.

Health Services Agency

- Supports the Community Traffic Safety Coalition program

Environmental Health

- Continued various efforts to improve ground and surface water quality and enhance riparian habitats.

- Continued efforts to promote water conservation and better manage water resources through greywater reuse, irrigation efficiency, groundwater recharge, and integrated regional water management.
- Participated in 2009 Update of State Water Plan and County EHS is now a member of the "Update 2013" Public Advisory Committee.
- Maintained a high level of staff time devoted to overseeing remediation of contaminated sites.
- Preparing an Integrated Regional Water Management Plan program investigating impacts of climate change and sea level rise on water resources and developing an adaptation plan.

Planning Department

- Continued participation in a cooperative planning process with other land use and transportation agencies for AMBAG's Sustainable Community Plan SB 375 planning processes to foster a lower carbon-footprint land use pattern.
- Received a $250,000 Disaster Recovery Initiative grant to update the General Plan Safety Ordinance, and flood and geo-hazard ordinances.
- Received a grant of $500,000 for Sustainable Communities Planning from the State Strategic Growth Council, which will fund the Santa Cruz County Sustainable Community and Transit Corridors Plan.
- Received award for outstanding lead agency administration of the State's Surface Mining and Reclamation Act (SMARA) from the State Department of Conservation for regulation of operation and post-operation restoration of the County's sand, gravel, limestone and shale mines.
- Extended and expanded implementation of the Master Permit for Environmental Enhancement Projects program, which provides a streamlined permitting process for small environmentally beneficial projects.
- Continue to administer, with the City of Scotts Valley, a Habitat Conservation Plan for the rare and endangered Sand Hills habitat areas.
- Worked with State Parks on Laguna Creek Estuary habitat restoration efforts.
- Preparing a Water Efficient Landscape Ordinance.
- Worked with the Department of Public Works on the County's Stormwater Runoff Pollution Prevention Ordinance.
- Periodically hold community training on erosion control plans and best practices

Agricultural Commissioner/Agricultural Extension

- Continued replacement of petroleum based mosquitocides with biological pesticides, biocontrol , educational and abatement measures
- Replacement of inefficient surveillance truck with hybrid vehicle
- Plans to heat mosquito fish holding troughs using solar rooftop water heating
- Staff have increased bicycle commuting to and from work
- Agricultural extension office conducts multiple research, education and outreach programs related to water, irrigation, fertilizer and other resource use efficiency in area agriculture and for home gardens.

Appendix B

List of Acronyms and Abbreviations

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List of Acronyms and Abbreviations

AB 32	Assembly Bill 32 – California Global Warming Solutions Act of 2006
AMBAG	Association of Monterey Bay Area Governments
CARB	California Air Resources Board
BAU	Business as Usual
CAC	Climate Action Compact
CAL Green	California Green Building Standards Code
CAO	County Administrative Office
CAPA	Climate Action Planning Assistant
CAS	Climate Action Strategy
CCA	Community Choice Aggregation
CCES	Central Coast Energy Services
CO_2e	Carbon Dioxide Equivalent
CNG	Compressed Natural Gas
CPUC	California Public Utilities Commission
CSAC	California State Association of Counties
CSI	California Solar Initiative
CTSC	Community Traffic Safety Coalition
CVRP	Clean Vehicle Rebate Program
CWD	Climatic Water Deficit
DPW	County of Santa Cruz Department of Public Works
EIR	Environmental Impact Report
EPR	Extended Producer Responsibility
EUC	Energy Upgrade California
GBP	Green Business Program
GHG	Greenhouse Gas
GSD	County of Santa Cruz General Services Department
IPCC	Intergovernmental Panel on Climate Change
IRWMP	Integrated Regional Water Management Plan
JPA	Joint Powers Authority
LED	Light Emitting Diode
MT	Metric Tons
PACE	Property Assessed Clean Energy
Planning	County of Santa Cruz Planning Department
PG&E	Pacific Gas & Electric Company
PPM	Parts Per Million
RPS	Renewable Portfolio Standard
RTC	Santa Cruz County Regional Transportation Commission
RTP	Regional Transportation Plan
VMT	Vehicle Miles Traveled
WELO	water efficient landscape ordinance
WUI	Wildland Urban Interface

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Appendix C

Regulatory Framework that Supports Climate Action in Santa Cruz County

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Regulatory Framework that Supports Climate Action in Santa Cruz County

Measure J

In 1978, voters in Santa Cruz County passed by initiative ordinance what is probably the most extensive and effective county growth management program in California. Measure J established polices to preserve a distinction between urban and rural areas, to encourage the location of new development in urban area, and to protect agricultural land and natural resources in rural areas. These policies were supported by the establishment a Rural Services Line (RSL) and an Urban Services Line (USL) to define areas that are or have the potential to be urban and areas which are and should remain rural. The establishment of these distinct urban boundaries serves the following purposes:

- To administer separate urban and rural growth rates and the allocation of residential building permits;
- To encourage residential development to locate in urban areas and to discourage division of land in rural areas;
- To develop and apply different policies governing urban and rural development;
- To provide a basis for a County Capital Improvements Program;
- To coordinate planning for the public services among the County, cities, special districts, and the Local Agency Formation Commission (LAFCO);
- To ensure that urban development proceeds at a pace consistent with the provision of urban public services; and
- To limit the extension of urban services to those areas within the Rural Services Line in the Coastal Zone (Chapter 17.02 of the County Code).

Additionally, Measure J has played and will continue to play an important role limiting the growth of green house gas emission in the County. By limiting the geographic scale of urban development Measure J has limited the growth of vehicle miles traveled in the County because most residential and commercial development has occurred within the USL. As a result, less driving is required for most people to access jobs and services. Although not quantified, Measure J has undoubtedly had a profound effect on the greenhouse emissions in the County because the transportation sector is the largest source of emissions.

Measure C – Decade of the Environment

Measure C was adopted by the voters of Santa Cruz on June 5, 1990, as an ongoing ten-year program that designates the 1990's as the "Decade of the Environment." Measure C serves as a guide to Santa Cruz County government in carrying out actions to help protect and restore the local environment, and to confront, on a local level, those environmental crises which that are global in scope. Chapter 16.90 of the County Code, which provides for implementation of Measure C, directs County government to work toward accomplishing the following:

- To provide for efficient use of renewable energy and recycled resources;
- To protect biological diversity and human health, through the protection and restoration of the environment;
- To encourage agricultural practices which are protective of the natural environment and human health;

- To promote and encourage economic development strategies in Santa Cruz County which are consistent with both environmental protection and restoration, and which will help create a local economy based on the use of renewable resources;
- To ensure that future growth and development in Santa Cruz County adheres to the natural limits and carrying capacity of the Santa Cruz County environment; and
- To take local actions which can help reverse, reduce, and eliminate practices which are contributing to global environmental crises.

Measure C also established a series of eleven principles and policies to guide local government efforts related to: offshore oil drilling; global warming and renewable energy resources; protection of the ozone layer; forest protection and restoration; greenbelt protection and preservation; recycling; toxic and radioactive materials; endangered species and biological diversity; development of a sustainable local economy; future growth and development; and education and outreach.

As requested by the Board of Supervisors, the Planning Department prepares an annual report on the Measure C "Decade of the Environment" Program, which identifies new initiatives throughout County government that have been undertaken to further program objectives related to energy conservation and environmental protection, as described in County Code Chapter 16.90.

General Plan

The County of Santa Cruz General Plan and Local Coastal Program (General Plan) was adopted by the Board of Supervisors in May of 1994 and certified by the California Coastal Commission in December of 1994. The document provides a set of policies and programs to guide future growth and development in a manner consistent with the goals and quality of life desired by the Santa Cruz County residents. The policies in the General Plan become the basis for all decisions related to the use of land and development within the County. The General Plan states that it serves two functions: as a regulatory framework against which all proposed development is measured; and as a vision statement for the desired future of the County. The following General Plan goals and policies of the Conservation and Open Space, Parks, Recreation and Public Facilities, and Community Design elements contribute to the reduction of greenhouse gas emissions.

Goals

- Open Space Protection: To retain the scenic, wooded, open space and rural character of Santa Cruz County; to provide a natural buffer between communities; to prevent development in naturally hazardous areas; and to protect wildlife habitat and other natural resources.
- Resource Utilization: To provide for the conservation and environmentally sound and orderly economic use of renewable and nonrenewable natural resources to provide employment and income in Santa Cruz County while minimizing impacts to adjoining land uses and the environment.
- Public Service Phasing: To coordinate the intensity, location, amount and timing of future development in the County with the provision of necessary public services, and to encourage new development to locate in urbanized areas where public services are available or can most readily and efficiently be provided or improved, and to achieve a rate of residential development in the County which can be accommodated by existing public services and facilities and their orderly and reasonable expansion, while maintaining high economic, social, and environmental quality.

- Community Design: To preserve and enhance the quality of life in Santa Cruz County through the guidance of development activity to protect open space for its aesthetic, recreational and environmental values, to foster high quality residential areas as pleasant and socially constructive areas in which to live, and to enhance the quality of residential, commercial and industrial development to achieve an aesthetic and functional community.

Policies

- Policy 5.1.12 – Habitat Restoration with Development Approval: Require as a condition of development approval, restoration of any areas of the subject property which is an identified degraded sensitive habitat, with the magnitude of restoration to be commensurate with the scope of the project. Such conditions may include erosion control measures, removal of non-native or invasive species, planting with characteristic native species, diversion of polluting run-off, water impoundment, and other appropriate means. The object of habitat restoration activities shall be to enhance the functional capacity and biological productivity of the habitat(s) and whenever feasible, to restore them to a condition which can be sustained by natural occurrences, such as tidal flushing of lagoons.
- Policy 5.1.13 – Habitats Damaged from Code Violations: In all cases where a sensitive habitat has been damaged as a result of a code violation, require that restoration of damaged areas be undertaken in compliance with all necessary permits and that the side of the restored area be in compliance with Department of Fish and Game requirements. Such restoration shall include monitoring over time to ensure the success of the restoration effort.
- Policy 5.11.5 – Designation of Resource Conservation Lands: Designate Resource Conservation areas on the General Plan and LCP Land Use maps to identify those lands which are publicly or privately held for conservation purposes. These preservation lands shall include significant open space lands in the rural areas of the County for the protection of natural resources and habitats, the managed production of resources, outdoor recreational opportunities and protection of public health and safety. Consider the following high priorities:
    - Expansion of established preserves, parks or open space areas and connections between existing preserved lands.
    - Areas with significant biological, scenic or other natural resource value which are not adequately protected by current County or other ordinances.
- Policy 5.12.1 – Designation of Timberlands: Designate on the General Plan and LCP Resources Maps those timberlands which are devoted to and used for growing and harvesting timber and which are capable of producing an average annual volume of wood fiber of at least 15 cubic feet per acre.
- Policy 5.14.8 – Encourage Biomass Cultivation: Encourage the cultivation of crops for biomass fuels without displacing existing agricultural production, especially when such biomass production makes use of marginal land or of crop residues and when the fuel or energy produced is consumed within Santa Cruz County.
- Policy 5.17.1 – Promote Alternative Energy Sources: Promote the use of energy sources which are reviewable, and less environmentally degrading than non-renewable fossil fuels.
- Policy 5.17.2 – Design Structures for Solar Gain: Require the incorporation of environmentally sound active and passive heating and cooling and/or natural daylighting design principles in the location and construction of all new buildings and in the renovation and remodeling of existing buildings.

- Policy 15.17.3 – Solar Access: Encourage maximum solar access orientation in siting new development, and require protection of solar access in existing development.
- Policy 15.17.4: Encourage and stimulate energy conservation and the use of renewable energy through retrofit programs for residential, agricultural, commercial, public facilities and industrial land uses.
- Policy 5.17.5 Weatherization Improvements: Require energy efficiency and weatherization improvements in existing and new development including insulation, water conservation techniques, and encourage the installation of solar heating systems. Require a retrofit to meet energy efficiency standards upon sale or transfer of ownership.
- Policy 5.17.7 – Street Lighting: Require installation of energy-efficient street lighting.
- Policy 5.17.8 – Unnecessary Waste: Restrict the use of decorative and advertising uses of electricity and fossil fuels, except where such restriction affects public safety.
- Policy 5.17.9 – Reclamation for Energy Recovery: Require sewage treatment and solid waste disposal projects to utilize sewage and solid waste reclamation and conversion techniques which provide resource conservation and net energy benefit to the County.
- Policy 5.18.1 – New Development: Ensure new development projects are consistent at a minimum with the Monterey Bay Unified Air Pollution Control District Air Quality Management Plan and review such projects for potential impact on air quality.
- Policy 5.18.6 – Plan for Transit Use: Encourage commercial development and higher density residential development to be located in designated centers or other areas that can be easily served by transit.
- Policy 5.18.7 – Alternatives to the Automobile: Emphasize transit, bicycles and pedestrian modes of transportation rather than automobiles.
- Policy 5.18.9 – Greenhouse Gas Reduction: Implement state and federal legislation promoting the national goal of 35 percent reduction of carbon dioxide and other greenhouse gasses by 2000.
- Policy 5.18.10 – Elimination of Ozone Depleting Chemicals: Support and implement local actions to achieve the most rapid possible international, national, state, and local elimination of the emission of ozone-depleting chemicals.
- Policy 7.22.3 – Use of Low Energy Gravity Transfer Systems: Where feasible, encourage sewage disposal systems in a new development to utilize natural gravity flow s to the maximum extent, reducing the energy costs associated with pumping.
- Policy 7.24.8 – Meeting State and Local Landfill Diversion Goals: Consider mandatory recycling or material-specific landfill disposal prohibitions if state and local landfill diversion goals are not met through the use of voluntary programs.
- Policy 7.25.4 – Buena Vista Landfill: Continue the use of the Buena Vista Landfill for landfill disposal and the Ben Lomond Transfer Station for solid waste transfer to Buena Vista. Utilize disposal methods and diversion practices at the Buena Vista Landfill to extend the landfill lifespan as long as possible.
- Policy 7.25.6 – Landfills and Environmental Protection: Ensure protection of the local environment, including air, groundwater and surface water resources through proper landfill design, construction, operation and on-going environmental monitoring.

- Policy 7.25.7 – Hazardous Wastes and Environmental Damaging Compounds in Landfills: Prohibit the disposal of radioactive waste, hazardous waste and ozone depleting compounds in County landfills.
- Policy 7.25.8 – Recyclable Materials in Landfills: Consider adoption of landfill disposal bans for specific recyclable or compostable materials where necessary to achieve County materials recovery and landfill diversion goals.
- Policy 7.25.9 – Access to Landfills and Materials Recovery Facilities: Continue to provide access to individual self-haul vehicles either at the Ben Lomond Transfer Station, the Buena Vista Landfill or at future Materials Recovery Facilities for refuse disposal, household hazardous waste drop-off and recycling and other materials recovery.
- Policy 7.25.11 – Methane Gas: Develop and implement a program for the recovery of landfill methane gas for conversion to electricity or direct use as a fuel.
- Policy 7.26.7 – Community Energy Systems: Allow the development of "Community Energy Systems" in locations where compatible with adjacent land use and with adequate mitigation of noise, emissions, and visual impacts.
- Policy 7.26.8 – Reusable Energy Sources: Consider the development of municipal solar utilities and other financing mechanisms which increase public access to renewable energy sources and provide opportunities for small-scale, decentralized local facilities and control.
- Policy 8.6.7 – Solar Access: Sunlight and solar access shall be maintained wherever practicable and energy-efficient building design shall be fostered. Passive solar siting shall be encouraged for all new development in accordance with adopted building and energy codes.
- Policy 8.7.2 – Utilize Native Species in Rural Areas: Require as a condition of development permit approval, revegetation and landscaping for rural projects to utilize drought tolerant species with a predominance of plants being native species appropriate to the site and recommend these landscape practices for ministerial permit projects.
- Policy 8.7.3 – Appropriate Plans in Urban Areas: Require urban projects, as a condition of development permit approval, to comply with the street tree guidelines of the Urban Forestry Master Plan, and to utilize acceptable species listed within the plan.

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Appendix D

Estimating the Potential Emissions Reduction of Individual Reduction Strategies

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Appendix D

Estimating the Potential Emissions Reduction of Individual Reduction Strategies

This material in this appendix expands on the information in Chapter 4.0 about the calculation of potential emissions reductions that can be expected from each emissions reduction strategy. Calculations were performed using the Climate Action Planning Assistant (CAPA) software tool developed by the Statewide Energy Efficiency Collaborative (SEEC). SEEC is a collaboration among three statewide non-profit organizations and California's four investor-owned utilities to provide support to cities and counties to help them reduce greenhouse gas emissions and save energy. With the assistance of the CAPA tool we were able to evaluate the potential for our Climate Action Strategy to achieve our long term community emissions reduction targets.

The CAPA tool uses calculator work sheets that address each major source of emissions to help estimate the emissions reduction potential of a wide variety of actions, and then to combine the estimates to show the potential GHG emissions reduction overall. This tool gives us the ability to create a more sophisticated action plan that incorporates the dynamic nature of the emissions generating processes and our efforts to improve them. Most critically, the concept of time and change over time can be incorporated into action planning. This is an absolute necessity for putting the scope of the challenge into focus and demonstrating the need for continuous improvement in our efforts.

The worksheets for reduction strategies that affect electricity use incorporate an "RPS Adjustment Factor". This field adjusts the emissions reduction associated with measures that are set to apply in the future. This correction is necessary because we have incorporated the effect of the State Renewable Portfolio Standard (RPS) as a separate reduction strategy. The adjustment accounts for the fact that the RPS will reduce emissions associated with electricity use in the future and, therefore, the calculated reductions must be reduced by a proportional amount to prevents the calculation from overestimating the potential emissions impact of measures that will operate in the distant future.

The reduction estimates are calculated for the period of 2005 – 2035. Emissions are expressed in metric tons of CO_2 (MT CO_2). The following table documents the assumptions that were made to complete the worksheets for each strategy, and the source of the information on which the assumption is based. Note that some of the sources are reports that are in draft or public review draft form at this time. This reflects the rapidly evolving character of the available data, and is one of the many ways in which the CAPA results are an estimate only.

All totals are rounded to the nearest 10 MT CO_2.

Statewide Initiatives

Clean Car Standards (Pavely I &II) and Low Carbon Fuel Standard (LCFS)

The Clean Car Standards call for the reduction of greenhouse gas emissions from light duty vehicles and the Low Carbon Fuel Standard (LCFS) calls for a reduction in the carbon intensity of California's transportation fuels by 2020. It is estimate that these standards will result in an overall 30 percent reduction in greenhouse gas emissions in the transportation sector in 2035.

Source: AMBAG, Draft Supplemental Environmental Impact Report, 2010 Monterey Bay Area Metropolitan Transportation Plan, Appendix F Greenhouse Gas Analysis.

Total Emissions Reduction: 186,450 MT CO_2e

Renewable Portfolio Standard (RPS)

The Renewable Portfolio Standard requires all of the state's electricity retailers to meet a 33 percent renewable energy target by 2020. It should be noted that percent renewable content does not always mean carbon-free content because some generation sources that are considered renewable, such as biogas, do produce some greenhouse gas emissions. For this calculation we assumed the 33 percent renewable target is achieved, and by 2035 further renewable energy development would result in a 50 percent carbon free portfolio for PG&E power. Using the emissions represented by the use of electricity in the 2009 inventory and the forecast emissions for 2035 a simple calculation was performed to estimate the emissions reduction represented by increasing the carbon-free renewable content of electricity generation in 2035 to 50 percent. The emissions reductions estimates from the RPS for our local area will vary depending on whether or not a CCA program is implemented. With no CCA program the reduction is estimated by applying the 50 percent carbon free portfolio to the entire projected electricity load in 2035. With a CCA program the reduction is estimated by applying a 50 percent carbon free portfolio to half of the project electricity load (PG&E customers), and a 100 percent carbon free portfolio to the remaining half of the projected electricity load (CCA customers) in 2035. The reductions reported here are for the RPS only. The reductions from a CCA program are reported separately

Total Emissions Reduction: 50% Load RPS: 34,820 MT CO_2e Full Load RPS:69,650 MT CO_2e

Total Emissions Reductions from Pavely I & II, LCFS, RPS: 221,270 MT CO_2e 256,100 MT CO_2e

Santa Cruz County Climate Action Strategy

Energy

Reduction Strategy: Community Choice Aggregation Program (50% Participation, 100% Carbon-Free)

Using the emissions from the use of electricity in the 2009 inventory and the forecast emissions for 2035 as inputs, the emissions reduction represented by increasing the renewable, carbon-free content to 100 percent for 50 percent of the projected electricity load in 2035 was estimated. This effectively eliminates emissions from 50 percent of the total projected load as a result of a CCA program.

50 percent participation was chosen randomly as a conservative estimate. The goal of a successful program would be closer to 100 percent participation by 2035 with a portfolio of 100 percent carbon free sources.

Total Emissions Reduction: 83,320 MT CO_2e

Reduction Strategy: Weatherization Programs

Weatherization programs that focus on low income residences provide simple repairs such as sealing cracks around windows and doors, adding insulation, and sometimes replacing inefficient appliances, thereby reducing energy-use-related GHG emissions and lowering utility bills. Santa Cruz County is served by Central Coast Energy Services (CCES) (http://www.energyservices.org/), which provides low and no cost weatherization and other energy services for low income residences. This calculator works by estimating the total number of homes that may receive weatherization services 2013 through 2035, using average electricity and gas savings from published data.

Average annual number of weatherizations completed: 213 homes

Source: CCES data 2005 through 2012

Electricity Savings per Home: 271 kWh/home

Source: California Energy Commission (CEC) “Options for Energy Efficiency in Existing Buildings”, CEC-400-2005-039-CMF, CEC, 2005.

Annual Electricity Savings: 57,723 kWh per year

Electricity Emission Coefficient: 0.000288 MT CO_2 per kWh

RPS Adjustment Factor: 0.75

Annual Electric Emission Savings: 12 MT CO_2 per year

Gas Savings per Home: 72 therms/home

From CEC”Options for Energy Efficiency in Existing Buildings”, CEC-400-2005-039-CMF, CEC, 2005.

Annual Gas Savings: 15,336 therms per year

Gas Emission Coefficient: 0.0053435 MT CO_2e per therm

Annual Gas Emission Savings: 82 MT CO_2 per year

Total Annual Emission Savings: 94 MT CO_2 per year

Implement cumulatively by increasing implementation by the above amount every year.

Reduction Strategy: Weatherization Programs
Number of years after installation that the measure is expected to continue to provide emission reductions: 22 years
Total Emission Reduction: 2,070 MT CO_2e

Reduction Strategy: AMBAG Energy Watch Projects (2006 to Q2 of 2012)
AMBAG Energy Watch municipal, non-profit, hospitality, residential and PowerSave programs PG&E data provided by AMBAG Electricity Savings: 5,569,138.8 kWh Electricity Emission coefficient: 0.000288 MT CO_2 per kWh RPS adjustment factor: 0.75
Total Emissions Reduction: 1,200 MT CO_2

Reduction Strategy: AMBAG Energy Watch Projects (Current and Pending)
PG&E data provided by AMBAG Electricity Savings: 422,358 kWh Electricity Emissions Coefficient: 0.000288 MT CO_2 per kWh RPS Adjustment factor: 0.75 Electricity Emissions Savings: 91 MT CO_2 Natural Gas Savings: 40,874 therms Gas emissions coefficient: 0.005316611 MT CO_2 per therm Gas Emissions Savings: 217 MT CO_2
Total Emission Reduction: 310 MT CO_2

Reduction Strategy: AMBAG Energy Watch Projects (Future)
Annualized average projection based on historical participation rates. Assumes similar participation rates to the 2006-Q2 of 2012 in future years. Emissions Reduction 2006 thru Q2 of 2012: 1,203 MT CO_2 Annualized emissions: 185 MT CO_2 per year 1203 / 26 (number of quarters 2006-Q2 of 2012) x 4 (number of quarters per year) Implement cumulatively by increasing implementation by the above amount every year. Number of years after installation that the measure is expected to continue to provide emission reductions: 20 years
Total Emission Reduction: 3,700 MT CO_2

Reduction Strategy: PG&E Energy Efficiency Programs

PG&E Programs (55)

PG&E data provided by AMBAG

Electricity Savings: 17,123,063.2 kWh

Electricity Emission factor: 0.000288 MT CO_2 per kWh

RPS Adjustment: 0.75

Electricity Emissions Reduction: 3,699 MT CO_2e

Natural Gas Savings: 40,432 therms

Natural Gas Emissions factor: 0.005316611 MT CO_2 pertherm

Gas Emissions Reduction: 215 MT CO_2e

***Total Emissions Reduction: 3,910* MT CO_2**

Reduction Strategy: PG&E Energy Efficiency Programs (Future)

Annualized Average projection based on historical participation rates. Assumes similar participation rates to the 2006-Q2 of 2012 in future years.

Emissions Reduction 2006 thru Q2 of 2012: 3,914 MT CO_2

Annualized Emissions: 602 MT CO_2 per Year

3,914 / 26 (number of quarters 2006-Q2 of 2012) x 4 (number of quarters per year)

Implement cumulatively by increasing implementation by the above amount every year.

Number of years after installation that the measure is expected to continue to provide emission reductions: 20 years

Total Emission Reduction: 12,040 MT CO_2

Reduction Strategy: Restaurant Retrofit Program

AMBAG Energy Watch Program

Projections provided by AMBAG Energy Watch Program

Typical Emissions Reductions (per unit replaced/upgraded)

- Combination Electric Oven (F100) = 18,432 kWh/unit (5.3 MT CO_2e)
- Pressureless Steamer (F108) - 11,166 kWh/unit (3.2 MT CO_2e)
- Grill-to-order Line (F144) - 15,167 kWh/unit (4.3 MT CO_2e)
- PRINCE CASTLE DHB4SS-20 UNIT - 18HRS (F147) - 31,631 kWh/unit (9.1 MT CO_2e)
- HIGH EFFICIENCY GAS STEAMER (F109)- 2,084 therms/unit (11 MT CO_2e)
- COMMERCIAL RACK OVEN SINGLE (F141)- 1,034 therms/unit (5.5 MT CO_2e)
- FLEXIBLE BATCH BROILER (F152)- 1089 therms/unit (5.7 MT CO_2e)

Reduction Strategy: Restaurant Retrofit Program
Average Emissions Reduction per restaurant: 10 MT CO_2e
Number of restaurants retrofitted: 10 per year
Total Annual Emission Reduction: 100 MT CO_2 per year
Implement cumulatively by increasing implementation by the above amount every year.
Number of years after installation that the measure is expected to continue to provide emission reductions: 20 years
Total Emission Savings: 2,000 MT CO_2

Reduction Strategy: Right Lights (2006 to Q2 of 2012)
A program of Ecology Action affecting commercial buildings
PG&E data provided by AMBAG Energy Watch Program
Electricity Savings: 5,640,083 kWh
Electricity Emission factor: 0.000288 MT CO_2e per kWh
RPS Adjustment: 0.75
***Total Emissions Reduction: 1,220* MT CO_2e**

Reduction Strategy: Right Lights (Future)
Annualized Average projection based on historical participation rates. Assumes similar participation rates to the 2006-Q2 of 2012 in future years.
Emissions Reduction2006 thru Q2 of 2012: 1,218 MT CO_2e
Annual Emissions Reduction: 187 MT CO_2e/yr 1,218 / 26 (number of quarters 2006-Q2 of 2012) x 4 (number of quarters per year)
Implement cumulatively by increasing implementation by the above amount every year.
Number of years after installation that the measure is expected to continue to provide emission reductions: 20 years.
Total Emission Reduction: 3,740 metric tons

Reduction Strategy: Energy Retrofits at Time of Sale
Ensure implementation of improvements to existing buildings by requiring improvements when renovations are made or when buildings are sold. There were 1,026 residential real estate transactions in unincorporated Santa Cruz County in 2011 (Santa Cruz Association of Realtors (SCCAR)).
Annual number of inspections and tune ups: 1,026 homes Source: 1,026 homes sold in 2011 (SCCAR website)
Electricity Savings per Home: 535 kWh per home

Reduction Strategy: Energy Retrofits at Time of Sale

Source: "Options for Energy Efficiency in Existing Buildings", CEC-400-2005-039-CM, CEC, 2005.

Annual Electricity Savings: 548,910 kWh per year

Electricity Emission Coefficient: 0.000288 MT CO_2 per kWh

RPS Adjustment Factor: 0.75

Annual Electric Emission Savings: 119 MT CO_2 per year

Gas Savings per Home: 26 therms per home

From CEC. 2005. Options for Energy Efficiency in Existing Buildings. CEC-400-2005-039-CMF.

Annual Gas Savings: 26,676 therms per year

Gas Emission Coefficient: 0.0053435 MT CO_2e per therm

Annual Gas Emission Savings: 143 MT CO_2 per year

Total Annual Emission Savings: 262 MT CO_2 per year

Implement Cumulatively by increasing implementation by the above amount every year.

Number of years after installation that the measure is expected to continue to provide emission reductions: 20 years

Total Emission Reduction: 5,240 MT CO_2

Reduction Strategy: Green Business Program (Certified Prior to 2013)

128,886 lbs/year per business = 58.4 MT CO_2e/year per business

Source: Jo Fleming, Regional Green Business Program Coordinator, personal communication

Total Emission Savings: 610 metric tons

Reduction Strategy: Green Business Program (Growth/Expansion)

128,886 lbs/year per business = 58.4 MT CO_2e/year per business

Source: Jo Fleming, Regional Green Business Program Coordinator, personal communication.

Degree of implementation: 10 new businesses per year

Annual emissions savings: 584 MT CO_2e per year

Implement cumulatively by increasing implementation by the above amount every year.

Number of years after installation that the measure is expected to continue to provide emission reductions: 20 years.

Total Emission Savings: 11,680 MT CO_2

Reduction Strategy: Solar Photovoltaics

California Solar Initiative (CSI) - rebates and other incentives for renewable energy systems

Reduction Strategy: Solar Photovoltaics

Total installed capacity 2007 to 2011: 1,515 kW

Source: CSI website, data for small commercial <10kW and residential

Generation Potential: 1,643 kWh/kW

Adapted from Table AE-2.1 of "Quantifying Greenhouse Gas Mitigation Measures", CAPCOA, August 2010. http://www.capcoa.org/wp-content/uploads/2010/11/CAPCOA-Quantification-Report-9-14-Final.pdf

Electricity Produced: 2,489,145 kWh

Electricity Emission Coefficient: 0.000288 MT CO_2 per kWh

RPS Adjustment Factor: 0.75

Emission Reduction: 540 MT CO_2

Reduction Strategy: Solar Photovoltaics (Growth)

Annualized average projection based on historical participation rates. Assumes similar participation rates to the 2007 to 2011 annual rates in future years.

Average annual emission reduction 2007 to 2011: 108 MT CO_2

Implement cumulatively by increasing implementation by the above amount every year.

Number of years after installation that the measure is expected to continue to provide emission reductions: 20 years

Total Emission Reduction: 2,160 MT CO_2

Reduction Strategy: Solar Water Heaters

California Solar Initiative Thermal – rebates and other incentives for solar thermal installation. The number of solar thermal systems installed is estimated due to a lack of specific data. Energy saved is based on published data.

Systems Installed: 136

Estimate: Number of PV systems installed 2007 to 2011 (272) reduced by half.

Percent Electric Water Heaters: 10 percent

Source: California Residential Appliance Saturation Survey (California Energy Commission, 2009)

Electricity Savings per System: 2,889 kWh/system

Source: Average performance values by Climate Zone, obtained from the Solar Rating and Certification Corporation Rating Directory. The SRCC is a non-profit corporation that develops and implements national rating standards and certification programs for solar energy equipment.

Electricity Savings: 29,290 kWh

Electricity Emission Coefficient: 0.000288 MT CO_2 per kWh

RPS Adjustment Factor: 0.75

Reduction Strategy: Solar Water Heaters

Electric Emission Savings: 8 MT CO_2

Percent Gas Water Heaters: 90 percent

Calculated as the remainder from the percent electric water heaters

Gas Savings per System: 137 therms/system

Average performance values by climate zone, obtained from the Solar Rating and Certification Corporation Rating Directory. The SRCC is a non-profit corporation that develops and implements national rating standards and certification programs for solar energy equipment.

Gas Savings: 16,769 therms

Gas Emission Coefficient: 0.0053435 MT CO_2 per therm

Gas Emission Savings: 90 MT CO_2

Total Emission Reduction: 100 MT CO_2

Reduction Strategy: Solar Water Heaters (Growth)

Annualized average projection based on historical participation rates. Assumes similar participation rates to the 2007 to 2011 annual rates in future years.

Average annual emission reduction 2007 to 2011: 20 MT CO_2

Implement cumulatively by increasing implementation by the above amount every year.

Number of years after installation that the measure is expected to continue to provide emission reductions: 20 years

Total Emission Savings by 2035: 400 MT CO_2

Reduction Strategy: Wind Power

Based on a lack of data and apparent low level of wind power generation in the County it was assumed that one typical system per year is installed.

Annual installed capacity: 50 kW

Small wind turbines have a rated output of less than 100 kW, and produce enough energy to power a home, small business, school or government building.

Generation Potential: 1,520 kWh/kW Installed per year

The value of 1520 kWh/kW of Capacity was derived from data from the California electronic Wind Performance Reporting System (eWPRS). Figure represents the average of the average performance of 43 installations ranging in capacity from 13 - 13,000 kW.

Annual Electricity Produced: 76,000 kWh per year

Electricity Emission Coefficient: 0.000288 metric tons per kWh

RPS Adjustment Factor: 0.75

Annual Electric Emission Savings: 16 metric tons per year

Implement cumulatively by increasing implementation by the above amount every year.

Number of years after installation that the measure is expected to continue to provide emission reductions: 20 years.

Total Emission Reduction: 320 MT CO_2

Reduction Strategy: Education - Residential

One of the most effective ways of communicating about energy use is through an energy audit. This calculator works by estimating the number of homes per year that are made more efficient by owners with knowledge (various programs) on how they are using power and how to efficiently cut back.

Annual number of inspections (Whole-House Diagnostic Audits) and tune ups: 50 homes

Electricity Savings per Home: 1,650 kWh per home

From CEC. 2005. Options for Energy Efficiency in Existing Buildings. CEC-400-2005-039-CMF.

Annual Electricity Savings: 82,500 kWh per year

Electricity Emission Coefficient: 0.000288 MT CO_2 per kWh

RPS Adjustment Factor: 0.75

Annual Electric Emission Savings: 18 MT CO_2 per year

Gas Savings per Home: 68 therms/home

From ”Options for Energy Efficiency in Existing Buildings“, CEC-400-2005-039-CMF, CEC 2005..

Annual Gas Savings: 3,400 therms per year

Gas Emission Coefficient: 0.0053435 MT CO_2e per therm

Annual Gas Emission Savings: 18 metric tons per year

Total Annual Emission Savings: 36 metric tons per year

Implement Cumulatively by increasing implementation by the above amount every year.

Number of years after installation that the measure is expected to continue to provide emission reductions: 20 years

Total Emission Reductions: 720 MT CO_2

Reduction Strategy: Education – Business

As with residences, One of the most effective ways of communicating about energy use to businesses is through an energy audit. This calculator works by estimating the number of businesses per year that are made more efficient by owners with knowledge (Commercial Building Benchmarking) on how they are using power and how to efficiently cut back. “Benchmarking” is a new state law (AB 1103) requiring disclosure of energy information on commercial buildings upon whole-building sale, lease, or refinance.

Annual square feet of building space that will be audited and benchmarked: 100,000 Square Feet

(Due to lack of available data this a gross estimate for Santa Cruz County)

Electricity Savings per Square Foot: 0.13 kWh/square foot

From ”Options for Energy Efficiency in Existing Buildings“, CEC-400-2005-039-CMF, CEC 2005..

Annual Electricity Savings: 13,000 kWh per year

Reduction Strategy: Education – Business

Electricity Emission Coefficient: 0.000288 MT CO_2 per kWh

RPS Adjustment Factor: 0.75

Annual Electric Emission Savings: 3 MT CO_2 per year

Gas Savings per Square Foot: 0.002 therms per Square Foot

From "Options for Energy Efficiency in Existing Buildings",CEC-400-2005-039-CMF, CEC 2005..

Annual Gas Savings: 200 therms per year

Gas Emission Coefficient: 0.0053435 MT CO_2e per therm

Annual Gas Emission Savings: 1 MT CO_2 per year

Total Annual Emission Savings: 4 metric tons per year

Implement Cumulatively by increasing implementation by the above amount every year.

Number of years after installation that the measure is expected to continue to provide emission reductions: 20 years.

Total Emission Reductions: 80 MT CO_2

Reduction Strategy: Beyond Title 24 Residential

Santa Cruz County has adopted the 2010 California Green Building Standards Code (CALGreen Code), also known as Part 11 of Title 24 of the California Code of Regulations, including all residential and nonresidential mandatory measures. The provisions of the code apply to newly constructed buildings and additions 500 square feet or larger to existing buildings for all new work. For remodels, insulation meeting the mandatory feature requirements in the California Energy Code shall be installed at ceilings, walls, floors and water pipes, when these areas are exposed during remodeling. New appliances installed as part of any remodel, addition or new construction shall be Energy Star appliances. This calculator estimates the additional emissions reduction that could be achieve by adopting stricter standards that would result in 30 percent more energy efficiency. This calculator does not work cumulatively because it only accomplishes a reduced level of emissions from projected growth in emissions from new construction.

Area of building space to be constructed annually under the stricter standard: 288,540 Square Feet

2011 Santa Cruz County data for new homes, accessory dwelling units, duplexes, replacement homes, and additions 500 square feet or larger adjusted to approximate pre-recession levels of building activity.

Planned Percent Improvement over Title 24 2008: 30 percent

Percent of New Construction as Single Family Units: 100 percent

Baseline Electricity Intensity for PG&E service Area: 1.07 kWh per square foot per year

Annual Electric Savings: 92,621 kWh per Year

Electricity Emission Coefficient: 0.000288 MT CO_2 per kWh

RPS Adjustment Factor: 0.75

Annual Emission Savings: 20 MT CO_2 per year

Baseline Gas Use Intensity for PG&E service Area: 0.171465 therms per square foot per year

Annual Gas Savings: 14,842 therms per Year

Reduction Strategy: Beyond Title 24 Residential
Gas Emission Coefficient: 0.0053435 MT CO_2e per therm
Annual Emission Savings: 79 metric tons per year
Total Emission Reduction: 100 MT CO_2

Reduction Strategy: Beyond Title 24 Commercial
Area of building space to be constructed annually under the stricter standard: 102,086 2011 Santa Cruz County records of new commercial square footage adjusted to approximate pre-recession levels of building activity..
Planned Percent Improvement over Title 24 2008: 30 percent
Baseline Electricity Intensity for PG&E service area: 6.9 kWh per Square Foot per Year
Annual Electric Savings: 211,318 kWh per Year
Electricity Emission Coefficient: 0.000288 MT CO_2 per kWh
RPS Adjustment Factor: 0.75
Electricity Emission Reduction: 46 MT CO_2 per Year
Baseline Gas Use Intensity for PG&E service area: 0.104 therms per Square Foot per Year
Annual Gas Savings: 3,185 therms per year
Gas Emission Coefficient: 0.0053435 metric tons per therm
Gas Emission Reduction: 17 MT CO_2 per year
Total Emission Reductions: 60 MT CO_2

Santa Cruz County Climate Action Strategy

Transportation

Reduction Strategy: Reduce Vehicle Miles Traveled through Land Use Planning
This calculator reflects the results of the Rapid Fire modeling tool which calculates results based on empirical data and the latest research on the role of land use and transportation systems on automobile travel; emissions; and land, energy, and water consumption. It is a spreadsheet based tool developed by Vision California, a project funded by the California High Speed Rail Authority in partnership with the California Strategic Growth Council. The Rapid Fire model calculates VMT by applying assumptions about VMT to population growth based on research and empirical evidence. The model works by comparing two different development patterns: One applies the existing per capita VMT to the projected 2035 population assuming the increased population is accommodated by continuation of automobile-oriented development patterns, and the other applies a reduced per capita VMT to the projected 2035 population assuming the increased population is accommodated with a high percentage of mixed use and infill development. The overall reduction in VMT from a compact and urban development scenario corresponds to a reduction in emissions compared to the business as usual scenario. These estimates were calculated for the urban portion of Santa Cruz County. 2035 Projected Average Passenger Fuel Economy: 35 Miles per Gallon Source: U. S. Energy Information Administration, Annual Energy Outlook 2012, Figure 24. Current Population (2010): 47,190 Source: BAE Urban Economics, Demographic, Economic and Real Estate Market Existing Conditions Analysis, Transit Corridors Plan for Santa Cruz County, August 24, 2012 (Existing Conditions Report) Vehicle Miles Traveled per Capita: 7,648 miles/year Source: Santa Cruz County Community Greenhouse Gas Emissions Inventory, 2009 2035 Projected Population: 52,450 Source: Existing Conditions Report (High Projection) 2035 VMT Per Capita with transportation and land use strategies to reduce VMT: 6,118 miles/year VMT reduction of 20 percent Source: Calthorpe Associates (2011) Vision California, Charting Our Future, Statewide Scenarios Report Total VMT with population increase and no VMT reduction: 401,137,600 miles Total VMT with increase in population density: 320,889,100 miles VMT Reduced: 80,248,500 Miles Fuel Savings: 2,292,814 Gallons Gasoline Emissions Factor: 8.78 kg CO_2 per Gallon
Total Emission Reduction: 20,130 MT CO_2e

Reduction Strategy: Electric Vehicle (EV) Charging

The effect of EVs on GHG emissions will depend on the source of electricity used and the particular vehicles being compared. If EVs are charged from renewable energy, emissions are zero. For this calculation the number of replacement electric vehicles by 2035 is estimated from state EV goals. Emissions reductions are then estimated by subtracting the emissions associated with vehicle electricity consumption from emissions associated with gasoline consumption for the estimated number of vehicles.

Number of vehicles that will be replaced with an electric powered model 5,525 Vehicles

Santa Cruz County (unincorporated) proportional share by population of State EV Goals according to: "2012 ZEV ACTION PLAN, A Roadmap toward 1.5 Million Zero-emission Vehicles on California Roadways by 2025", Governor's Interagency Working Group on Zero-emission Vehicles, Governor Edmund G. Brown Jr., September 2012 [DRAFT VERSION FOR PUBLIC COMMENT]

Note: Santa Cruz County (unincorporated) proportional share by population of existing EVs: 42

Source: Number of Clean Vehicle Rebate Project (CVRP) rebate by vehicle type (FY 2009-2013)", Clean Vehicle Rebate Project website

Average annual miles traveled for all vehicles included in this calculation: 11,000 Miles

2035 Projected average vehicle fuel economy for all vehicles included in this calculation: 35 MPG

Gasoline Consumption Reduced: 1,723,229 Gallons per Year

Gasoline Emissions coefficient: 0.00878 MT CO_2 per gallon

CO_2 reduced from reduced gasoline consumption: 15,130 MT CO_2 per year

Fuel economy for the replacement electric vehicle: 105 MPGGe (Miles per Gallon Gasoline Equivalent)

Note: Electric vehicle fuel economy numbers are reported in terms of MPGGe. Values for a variety of models are available at www.FuelEconomy.gov

Equivalent Gallons of Gasoline Consumed: 574,410 Gallons

Energy conversion factor: 1 Gasoline Gallon = 36.6 kWh

Increased Electricity Consumption: 21,023,406 kWh

Electricity Emission Coefficient: 0.000288 MT CO_2 per kWh

RPS Adjustment Factor: 0.75

CO_2 Produced from electric vehicle charging: 4,541 MT CO_2

Net Emissions Reduction: 10,590 MT CO_2

Reduction Strategy: Carpooling

The carpool calculator works by accounting for the emissions reductions produced by increased numbers of commuter carpools and lower overall vehicle miles traveled as a result. Fuel efficiency and commute distances are projected for the 2035 scenario.

Commuters in the unincorporated areas of County that drove alone to work: 65,332 (2010 Census)

Commuters that carpool or took public transit: 12,537 (2010 Census)

Drive alone in 2035: 68,850

Source: Existing number of commuters that drive alone projected out to 2035 using a population growth rate of

Reduction Strategy: Carpooling
0.21 percent (AMBAG)
Estimate percent additional participation in carpools? in 2035: 8 percent
Source: Update In Process to Regional Transportation Plan: Goal 1: Target 1D: Decrease single occupancy vehicle mode share compared to the baseline condition between 2 to 8 percent by 2035.
Additional participants in 2035: 5,508
Average Daily Vehicle Miles Traveled: 22.5 Miles
Sources: 2035 projected average vehicle speed = 26.3 (2010 RTP Appendix H). Average travel time to work = 25.7 minutes (2010 Census). Assume constant average travel time to work. (26.3 x (25.7/60)) x 2 = 22.5
Working Days per Year: 240 Days
Total VMT: = 29,743,200 Miles
Average Vehicle Occupancy of Carpool Participants: 2
Vehicle Miles Reduced: = 14,871,600 Miles
Projected fuel economy in 2035: 35 MPG
Source: U. S. Energy Information Administration, Annual Energy Outlook 2012, Figure 24.
Gasoline Consumption Reduced: 424,903 Gallons per Year
(14,871,600/35)
Gasoline Emissions Factor: 8.78 kg CO_2 per Gallon
Total Emissions Reduction: 3,730 MT **CO_2e**

Santa Cruz County Climate Action Strategy

Solid Waste

Reduction Strategy: Landfill Gas to Energy
This calculator estimates the amount of existing electricity emissions could be offset if the electric power produced by landfill gas at the Buena Vista landfill were credited to the County of Santa Cruz instead of the current scenario in which the electricity production is purchase by another jurisdiction.
Annual Landfill Gas Emissions: 108, 748 MT CO_2e per year
Methane generation from landfill gas recovery in 2010
Source: "Applicability Review and Greenhouse Gas Emission Modeling for the Federal Mandatory Reporting Rule for Buena Vista Landfill", SCS Engineers , January 15, 2010.
Gas Collection Efficiency: 85 percent
Total Annual Methane Captured: 4,402 MT CH_4
Generator Efficiency: 35 percent
Typical values for various generator types: Microturbine: 25 percent, Combustion Turbine: 32 percent, Reciprocating Engine: 35 percent
Capacity Factor: 85 percent
Capacity factors account for system downtime and operational losses for the generator
Annual Electricity Produced: 17,462,640 kWh
Conversion of methane from mass to volume to energy units
Electricity Emission Coefficient: 0.000288 MT CO_2e per kWh
RPS Adjustment Factor: 0.75
Total Clean Energy Emissions Benefits: 3,770 MT CO_2e

Appendix E

Intergovernmental Panel on Climate Change

Global Emissions Scenarios for Greenhouse Gases

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Appendix E Intergovernmental Panel on Climate Change Global Emissions Scenarios for Greenhouse Gases		
Scenario	**Description**	**Estimated Increase in Temperature[1]**
A1	The A1 storyline and scenario family describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies. Major underlying themes are convergence among regions, capacity building, and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income. The A1 scenario family develops into three groups that describe alternative directions of technological change in the energy system. The three A1 groups are distinguished by their technological emphasis: fossil intensive (A1FI), non-fossil energy sources (A1T), or a balance across all sources (A1B).	
A1FI	Intensive dependence on fossil fuels.	7.2°F (4.0°C)
A1B	Balanced energy supply between fossil fuels and alternatives.	5.04°F (2.8°C)
A1T	Alternative technologies largely replace fossil fuels.	4.3°F (2.4°C)
A2	The A2 storyline and scenario family describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in continuously increasing global population. Economic development is primarily regionally oriented and per capita economic growth and technological change is more fragmented and slower than in other storylines.	6.1°F (3.4°C)
B1	The B1 storyline and scenario family describes a convergent world with the same global population that peaks in midcentury and declines thereafter, as in the A1 storyline, but with rapid changes in economic structures toward a service and information economy, with reductions in material intensity, and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social and environmental sustainability, including improved equity, but without additional climate initiatives.	3.2°F (1.8°C)
B2	The B2 storyline and scenario family describes a world in which the emphasis is on local solutions to economic, social, and environmental sustainability. It is a world with continuously increasing global population at a rate lower than A2, intermediate levels of economic development, and less rapid and more diverse technological change than in the B1 and A1 storylines. While the scenario is also oriented towards environmental protection and social equity, it focuses on local and regional levels.	4.3°F (2.4°C)
Source: Intergovernmental Panel on Climate Change, 2007 and IPCC 2000. Note: (1) Temperature at 2090-2099 relative to 1980-1999.		

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Appendix F

Public Comments from June 26, 2012 Public Meeting and September 19, 2012 Focus Group Meeting on the Preliminary Draft Climate Action Strategy

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Public Comments from June 26, 2012 Public Meeting and September 19, 2012 Focus Group Meeting on the Preliminary Draft Climate Action Strategy	
Comment	**Staff Notes**
Investigate role of agriculture and note the challenges in measurement	See Agriculture Section
Pre-sale retrofits for all home sales (including septic system). Address financial barriers to these changes.	See E 2.5: Time of Sale Ordinance
Public education for both mitigation and adaptation, for both youth and adults. Work with CREEC (California Regional Environmental Education Community) to implement education. Pilot with K-12 on public transit, biking, etc.	See E-8: Public Education
Address forest sequestration	See Forestry Section
Examine General Plan for inclusion of climate change considerations. Look at flood plain. Add reforestation and wetlands protection and restoration	Consider for future General Plan amendment
Coordinate with Metro to support land use changes that reduce VMT	See T-2: Reduce vehicle miles traveled through County and regional long range planning efforts
Renew “RideSpring”	See T-5: Increase County employee use of alternative commute modes
Look at how County ES (Emergency Services) interacts with Planning (to lessen vulnerability to climate change)	See Adaptation Section
Include fire risk and severe drought concerns in further planning investigations	See Adaptation Section
Develop incentives to work near your home (e.g. County government could implement a model. Consider Silicon Valley’s remote workers)	See T-2: Reduce VMT through County and regional long range planning efforts
Expansion of Green Business Program	See T-4: Enhance and expand the Green Business Program
Investigate the impact on our forest of climate change. Improve forest management.	See Forestry Section
Improve efficiencies in road travel in key corridors (e.g. Timing of traffic lights; Soquel/Water “Triangle”)	See T-1: Plan for a balanced, multimodal transportation network that meets the needs of all users of streets, roads, and highways for safe and convenient travel, in a manner that considers the rural, suburban, or urban context
Address Bike Safety Issues: improve bike travel routes	See T-1: Plan for a balanced, multimodal transportation network that meets the needs of all users of streets, roads, and highways for safe and convenient travel, in a manner that considers the rural, suburban, or urban context
Education: coordinate with other jurisdictions to have wider impact and publicize outside our community	See E-5: Public Education
Support the rail corridor	See T-1: Plan for a balanced, multimodal transportation network that meets the needs of all users of streets, roads, and highways for safe and convenient travel, in a manner that considers the rural, suburban, or urban

Public Comments from June 26, 2012 Public Meeting and September 19, 2012 Focus Group Meeting on the Preliminary Draft Climate Action Strategy	
Comment	**Staff Notes**
	context
Even when plugging electric vehicles into the dirtiest grid, EVs reduce GHG emissions by 50 percent. Cleaner grids offer an even further reduction without necessarily needing 100 percent renewables.	See Strategy T-3: Provide infrastructure to support zero and low emission vehicles (plug-in electric, hybrid, and fuel cell vehicles)
There is an existing methodology for agricultural emissions calculation — include agriculture in assessment of mitigation strategy	See Agriculture Section
Meat consumption produces more GHG heating emissions than all of transportation according to some studies, and there are multitudes of strategies to mitigate this (e.g. capturing the methane, feed mixtures that reduce methane, Meatless Mondays)	It is outside the scope of the CAS to address consumption of meat or other food or consumer products
Ethanol production from waste stream and grains. If grains are first used to make ethanol then fed to livestock, levels of methane produced decrease. Allow permits.	See Strategy E-4: Increase local renewable energy generation
Adopt all voluntary measures of CalGreen, especially as related to emission reductions. Individual assessments and reduction strategies as with climate action teams to record these reductions	See E-2: Continue to improve the Green Building Program by exceeding the minimum standards of the state green building code (Cal Green).
Allow composting toilets	Local regulations require that toilet waste must be disposed of in a septic tank or sewer connection.
Set specific performance goals at county facilities	See E-2.8 Green Government Certification and County facilities benchmarking data
Aquifer recharge—using different pavers and catchment	See Strategy E-8
Plant trees	See Forestry Section
No de-sal plant	The County has no jurisdiction over the current desalination proposal.
Monterey County “served” notice to developers and residents along the coast saying that we will not pay for or insure damage	See Table 7-1
Cooperate between jurisdictions to increase economies of scale on water recycling	Refer to Integrated Regional Water Management Planning process, responsibility: Environmental Health Services
More homeowner rebates for water efficiency measures	See E 8.1
Include disadvantaged communities and social justice in adaptation planning	See 5.14
Accurately describe limitations of the inventory by disclosing what is and is not included (i.e. Agriculture, machinery fuel use, fertilizer)	See Agriculture Section and Inventory data in Appendix
Modify behaviors through conservation incentives	Most of the proposed strategies in the CAS involve, or could result in incentives including E-1, E-2, E-3, E-4, E-6, E-8
Reduce production of EMFs at all levels (e.g. cell towers, smart meters, etc.)	It is outside the scope of the CAS to address EMF’s

Public Comments from June 26, 2012 Public Meeting and September 19, 2012 Focus Group Meeting on the Preliminary Draft Climate Action Strategy	
Comment	**Staff Notes**
Green building methods	E-3: Increase energy efficiency in existing residential buildings E-4: Increase energy efficiency in existing commercial buildings
Not "smart growth," but "smart development"	See T-4
Urban and rural reforestation with less concrete	See Forestry Section
No new development in coastal areas	See Table 7-1
Maintain / refurbish / retrofit below-pavement signal triggers to respond to bicycle traffic." At least half the signal triggers I travel over don't work. If the detectors were closer to the pavement surface or more sensitive, I wouldn't have to violate so many stop lights.	See T-4.14
Carbon tax	Staff will provide additional information as directed
Emphasize adaptation	See Adaptation Section
Coordinate with RTP update	See Strategy T-4
Address agricultural emissions	See Agriculture Section
Climate Action / Sustainability Coordinator	Staff will provide additional information as directed
Large houses waste energy	See Strategy E-6
Ongoing public education	See Strategy E-5
Improve transit and connections	See Strategy T-4
Mitigate transportation projects using STARS system	See Strategy T-4
Recognize the value of natural capital	See Adaptation Section and Forestry section
Advisory panel with public member	The Commission on the Environment
Fuel cells don't reduce emissions	According to the California Air Resources Board hydrogen production for fuel cell vehicles does produce greenhouse gas emissions but fewer than conventional cars.
More inter-jurisdictional coordination	See Strategy E-7 and Adaptation section

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Appendix G

Santa Cruz County Municipal and Community-wide Greenhouse Gas Inventories for the Years 2005 and 2009

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Santa Cruz County Municipal and Community-wide Greenhouse Gas Inventories for the Years 2005 and 2009

Introduction

There are many gases that contribute to the greenhouse effect, including Carbon Dioxide (CO_2), Methane (CH_4), Nitrogen Dioxide (NO_2) and others. Information on the three major greenhouse gases is provided in the following table, which includes the sources of these gases and their global warming potential (GWP).

Top Three Greenhouse Gases			
Gas	**Chemical Formula**	**Human Activity**	**Global Warming Potential (CO_2e)**
Carbon Dioxide	CO_2	Fossil Fuel Combustion	1
Methane	CH_4	Fossil Fuel, Combustion, Anaerobic Decomposition of Organic Waste (Landfills, Wastewater), Fuel Handling	21
Nitrous Oxide	N_2O	Fossil Fuel Combustion, Wastewater Treatment	310
Source: County of Santa Cruz, 2013.			

Emissions of CO_2 are the largest contributor, with minor contributions from CH_4, NO_2, and others. Some of these gases are more powerful modifiers of the atmosphere than others. For example, CH_4 is 21 times more powerful than CO_2 as a greenhouse gas, and NO_2 is 310 times more powerful than CO_2 as a GHG. The emissions inventory combines emissions from different greenhouse gases and converts the emissions to equivalent amounts of CO_2 for final reporting purposes. The term CO_2e (carbon dioxide equivalent) will be used throughout this report as the standard measurement for greenhouse gas accounting.

Emissions are calculated using **activity data** and **emissions factors**. Examples of activity data include electricity consumption in kilowatt hours (kWh), natural gas consumption in therms of natural gas, fuel consumed in gallons, and vehicle miles traveled (VMT). An emissions factor is the quantity of greenhouse gas emissions per unit of activity, such as kilograms (kg) of CO_2 per kWh, or kg CO_2 per gallon of fuel, or per mile driven. Use of electricity is associated with emissions at the power generating sources largely located outside the County. These are called indirect emissions. Direct emissions result from burning natural gas in our homes and businesses, and fuel use and miles driven in our cars. Emissions are reported in units of metric tons of CO_2e (MT CO_2e) using standard conversion factors in the calculations (e.g. 1,000 kg equals 1 metric ton). Emissions factors used in the calculations are listed in the following table:

Emissions Factors (kgCO2e)			
Activity	**2005**	**2009**	**Percent Change**
Electricity	0.2237 kg/kWh	0.2626 kg/kWh	15%
Natural Gas	5.3166 kg/Therm	5.3166 kg/Therm	0%
Gasoline	8.78 kg/gallon	8.78 kg/gallon	0%
Diesel	10.21 kg/gallon	10.21 kg/gallon	0%
Vehicle Class	kg/mile	kg/mile	Varies by vehicle class
Source: County of Santa Cruz, 2013.			

The electricity emissions factor changes depending on the type of fuel used to generate electricity at each source (natural gas, nuclear, coal, hydro, etc.) and the source's level of contribution to the overall power supply in a given year. Because the PG&E "power mix" varies from year to year, the electricity emissions factor

changes accordingly. The increase in the emissions factor in 2009 indicates the PG&E power mix was more dependent on fossil fuel sources of electricity compared to 2005. It is important to keep this in mind when analyzing the emissions inventory because a higher emissions factor will increase total emissions even if electricity use does not increase, or even if electricity use goes down.

The various emissions factors for fuels (natural gas, gasoline, and diesel) remain constant from year to year because the carbon content of specific fossil fuel types does not change.

Emissions by vehicle class are determined using a computer model developed by the California Air Resources Board. The model (EMFAC2007) draws from a variety of datasets, such as DMV data, to calculate emission factors by accounting for the emissions characteristics of the current population of registered vehicles in each vehicle class in Santa Cruz County. Vehicle classes range from passenger cars to light-, medium-, and heavy-duty trucks, and motorcycles of all fuel types.

For clarity, emissions factors are grouped in the table above and the tables below contain information on activity data and total emissions.

Inventories were prepared for the years 2005 and 2009. 2005 is a commonly accepted baseline year for greenhouse gas inventories for jurisdictions in California because it aligns with guidance from the State and the approach of most local jurisdictions throughout the State. The 2005 inventory is based largely on data for 2005, but some data from other years was used as a proxy when data were not available for 2005. The inventory update was done for the year 2009 because it was the most recent year for which an updated emissions factor was available from PG&E for electricity. Similarly, the 2009 inventory is based largely on data for 2009, but some data from other years was used as a proxy when data were not available for 2009.

The numbers reported in the tables below have been rounded for reporting purposes.

Santa Cruz County Municipal Greenhouse Gas Inventory

In 2008, the County participated in the International Council for Local Environmental Initiatives (ICLEI)/Sustainable Silicon Valley (SSV) Silicon Valley Climate Protection Partnership program through the Joint Venture Silicon Valley Network to inventory greenhouse gas (GHG) emissions from County operations. As a result of this partnership an inventory of emissions from County government operations for the baseline year of 2005 was completed. The inventory was one of the first inventories to use a new national standard developed and adopted by the California Air Resources Board (CARB) in conjunction with ICLEI, the California Climate Action Registry (CCAR), and The Climate Registry (TCR). This standard, called the Local Government Operations Protocol (LGOP), provides standard accounting principles, boundaries, quantification methods, and procedures for reporting GHG emissions from local government operations. This emissions inventory represents an estimate of emissions using the best available data and calculation methodologies.

The inventory examined the County's GHG impact in the sectors of solid waste, buildings and facilities, vehicle fleet, wastewater treatment, public lighting, employee commute, and water systems. The inventory includes only those activities that the County has direct operational control over.

The County's total calculated emissions were 38,901 MT CO_2e in 2005, dropping almost 12 percent to 34,267 MT CO_2e in 2009. This reduction can be attributed largely to a decrease in fugitive methane emissions from the Buena Vista and Ben Lomond landfills, and to a lesser extent apparent reductions in employee commutes and county vehicle fleet use. The largest source of emissions is fugitive methane emissions from the landfills, followed by fuel use by employees commuting, natural gas and electricity to heat and power buildings, fuel use by the vehicle fleet, and other County facilities such as sewage pump stations, public lighting, water delivery related activities.

Government Operations Emissions by Sector			
Sector	MT CO_2e Emitted		Percent Change from 2005 Baseline
	Year 2005	Year 2009	
Solid Waste Facilities	20,261	18,335	-10%
Employee Commute	6,928	5,370(1)	-22%(1)
Buildings and Facilities	5,525	5,847	6%
Vehicle Fleet	5,253	3,673	-30%
Wastewater Treatment Facilities	848	941	11%
Public Lighting	62	69	11%
Water Delivery	24	32	33%
Total	**38,901**	**34,267**	**-12%**

Note:
(1) The reduction in emissions from the employee commute is largely due to a reduction in employees between 2005 and 2009
Source: County of Santa Cruz, 2013.

Solid Waste

Landfills contribute direct emissions of greenhouse gases to the atmosphere in the form of methane gas created by the anaerobic decomposition of buried waste. Both the Buena Vista and Ben Lomond landfills have landfill gas collection systems installed. The landfill gas collected at Ben Lomond is destroyed by a flare. The landfill gas collected at the Buena Vista landfill is used to power a cogeneration facility, and some is destroyed by a flare. Emissions to the atmosphere of GHGs result from methane that escapes the collection system and is not destroyed in a flare or engine generator. The estimate of the amount of methane that escapes the collection system involves a calculation using a number of factors including surface area of the landfill and collection system, the amount of landfill gas collected, the percentage of methane in the landfill gas, the destruction efficiency of methane in the collection system, and the collection efficiency of the system. While there is good accuracy on most of these factors, estimating collection efficiency of a landfill gas collection system is difficult. Based on a review of surface monitoring data collected at the landfill and various studies of collection efficiency in well controlled landfills, a reasonable collection efficiency factor was determined. As further studies are done this collection efficiency factor may change, and the inventory can be adjusted accordingly. The solid waste sector also includes emissions as a result of the use of electricity and natural gas in buildings and facilities associated with landfill operations.

The solid waste sector contributed about half of the County's emissions in 2005 and 2009. The estimate of emissions of methane gas from the Buena Vista and Ben Lomond landfills decreased between 2005 and 2009 by almost 10 percent. This decrease could be attributable to improvements in the landfill gas collection systems and/or a reduction in methane gas generation by decomposing garbage. Emissions of GHGs as a result of escape of landfill gas from the landfills and the use of electricity and natural gas are summarized in the following tables:

Landfill Gas			
Year	Methane Emissions (MT CH_4)		Emissions (MT CO_2e)
	Buena Vista	Ben Lomond	
2005	907	51	20,124
2009	827	42	18,245

Source: County of Santa Cruz, 2013.

Landfill Electricity			
Year	Consumption (kWh)		Emissions ($MT CO_2e$)
	Buena Vista	Ben Lomond	
2005	433,357	125,765	125
2009	229,224	84,316	82
Source: County of Santa Cruz, 2013.			

Landfill Natural Gas			
Year	Consumption (Therms)		Emissions ($MT CO_2e$)
	Buena Vista	Ben Lomond	
2005	2,200	0	12
2009	1,507	0	8
Source: County of Santa Cruz, 2013.			

Landfill Summary ($MT CO_2e$)				
Year	Methane Emissions	Emissions from Electricity Use	Emissions from Natural Gas Use	Total Landfill Emissions
2005	20,124	125	12	**20,261**
2009	18,245	82	8	**18,335**
County of Santa Cruz, 2013.				

Employee Commute

The employee commute sector contributed about one sixth of the County's GHG emissions in 2005 and 2009. This sector realized a decreased in GHG emissions of about 22 percent. The reduction in emissions from the employee commute is largely due to a reduction in employees between 2005 and 2009

An estimate of overall vehicle miles traveled (VMT) was based on a County employee commute survey conducted in 2008. This information was used as a proxy for this sector in the overall 2005 emissions inventory. Survey questions were designed to obtain information on the type of vehicle and commute distance (VMT). VMT were converted to fuel consumption using estimates of fuel efficiency for each vehicle type. Fuel consumption estimates from the 2008 employee commute survey were multiplied by emissions factors for transport fuels to obtain total emissions.

2008 Employee Commute			
Fuel Type	Vehicle Miles Traveled	Fuel Consumption (gallons)	Emissions ($MT CO_2e$)
Gasoline		142,403	6,902
Diesel		453	26
Total	**14,240,655**		**6,928**
Source: County of Santa Cruz, 2013.			

A subsequent estimate of overall VMT was based on a second County employee commute survey conducted in 2011. This information was used as a proxy for this sector in the overall 2009 emissions inventory. The survey questions were designed to obtain information on the type of vehicle and commute distance (VMT). The 2011 survey was simplified compared to the 2008 survey by limiting the number of questions. As a result the response rate was increased from about 22 percent in 2008 to about 39 percent in 2011.

The information on VMT and vehicle type from the 2011 employee commute survey was multiplied by an emission factor for each vehicle type to estimate GHG emissions. Categories of vehicle types used in the 2008 survey and the 2011 survey are not comparable due to inconsistent categorization.

2011 Employee Commute		
Vehicle Type	**Vehicle Miles Traveled**	**Emissions ($MT CO_2e$)**
Passenger Car	7,463,112	3,071
Light Duty Truck	2,928,609	1,490
Medium Duty Truck	524,522	365
Heavy Duty Truck	453,365	428
Motorcycle	138,966	17
Total	**11,508,574**	**5,370**
Source: County of Santa Cruz, 2013.		

Buildings and Facilities

The buildings and facilities sector contributed about one sixth of the County's emissions in 2005 and 2009. This sector realized an almost six percent increase in GHG emissions between 2005 and 2009. The increase could have been caused by a combination of factors. While there was an increase in natural gas use, there was a significant decrease in the use of electricity, which is likely the result of County efforts to conserve energy and increase energy efficiency in buildings and facilities. However, the decrease in electricity use did not result in a proportional reduction in GHG emissions because the decreased energy use was partially offset by an increase in the Pacific Gas & Electric (PG&E) emission factor.

Activity data in this sector is from PG&E records of electricity and natural gas usage in 2005 and 2009 for all facilities under direct operational control of the County of Santa Cruz. This includes buildings, parks, sanitary sewer collection system, small scale wastewater treatment facilities, traffic lights and other public lighting, and water facilities (Davenport treatment plant, irrigation and storm water control system).

2005 Major Buildings and Facilities			
Facility	**Electricity Use (kWh)**	**Natural Gas Use (therms)**	**Emissions ($MT CO_2e$)**
Detention Centers*	1,496,087	291,958	1,887
Government Center	3,863,400	56,278	1,164
Emeline Complex	2,717,152	76,537	1,015
Simpkins Swim Center*	50,880	161,195	868
Animal Services	307,479	9,087	117
Minor Facilities	1,195,941	23,834	394
Stationary Refrigerants	N/A	N/A	80
Total	**9,630,939**	**618,889**	**5,525**
Source: County of Santa Cruz, 2013.			

2009 Major Buildings and Facilities			
Facility	**Electricity Use (kWh)**	**Natural Gas Use (therms)**	**Emissions (MT CO_2e)**
Detention Centers*	1,345,925	312,910	2,012
Government Center	3,364,951	48,234	1,134
Emeline Complex	2,812,506	94,834	1,237
Simpkins Swim Center*	31,280	162,326	870
Animal Services	271,950	21,342	184
Minor Facilities	848,319	20,632	331
Stationary Refrigerants	N/A	N/A	80
Total	**8,674,931**	**660,278**	**5,847**

Source: County of Santa Cruz, 2013.

Vehicle Fleet

This sector contributed about one sixth of the County's GHG emissions. Between 2005 and 2009 emissions in this sector dropped about 30 percent. All of the decrease was cause by a decrease in fuel use in the Public Works Department, while most other department's fuel use stayed the same or increased slightly.

The County has two vehicle fleets, the fleet managed by the General Services Department, and the fleet managed by the Public Works Department. Each department purchases and manages fuel separately. Detailed fuel use data was provided by these two departments for 2005 and 2010. The data was conditioned to separate out fuel use by department. Some vehicles in the General Services fleet purchase fuel from Public Works, and vice versa, which added complexity to the process of assigning absolute fuel use to each department.

2005 Fleet Emissions by Department				
Function	**Gasoline Use (gal)**	**Diesel Use (gal.)**	**CNG Use (gal.)**	**Emissions (MT CO_2e)**
Public Works	166,342	219,505		3,702
Sheriff	85,513		225	752
General Services	11,744		835	109
Health Services Agency	12,773		146	113
Parks	17,745		737	161
District Attorney	7,965			70
Human Services Dept.	9,779			86
Probation	6,128		434	57
Agriculture Commission	8,643			76
Planning	6,894			61
Animal Services	5,745			50
Minor Functions(1)	1,874			16
Totals	**341,143**		**2,377**	**5,253**

Note:
(1) Minor Functions include Agricultural Extension, Assessor, Department of Child Support Services, Elections, Information Services, Office of Emergency Services, Recorder, Radio Shop
Source: County of Santa Cruz, 2013.

2010 Fleet Emissions by Department				
Function	Gasoline Use (gal)	Diesel Use (gal.)	CNG Use (gal.)	Emissions (MT CO_2e)
Public Works	78,651	122,582		1,942
Sheriff	102,243		54	898
General Services	18,403		411	164
Health Services Agency	14,780		176	131
Parks	15,046		681	137
District Attorney	8,421			74
Human Services Dept.	7,781			68
Probation	7,669		171	69
Agriculture Commission	7,902			69
Planning	5,470			48
Animal Services	4,982			44
Minor Functions(1)	3,252			29
Totals	**274,600**	**122,582**	**1,493**	**3,673**

Note:
(1) Minor Functions include Agricultural Extension, Assessor, Department of Child Support Services, Elections, Information Services, Office of Emergency Services, Recorder, Radio Shop
Source: County of Santa Cruz, 2013.

Wastewater Treatment Facilities

The Santa Cruz County Sanitation District (District) operates the system of pump stations and other facilities to collect and transport sewage from unincorporated areas of the County to the waste water treatment facility in the City of Santa Cruz. Operation of District facilities creates emissions from the use of electricity and natural gas. This sector does not include emission from the wastewater treatment facility in the City of Santa Cruz. Additionally, this sector includes emission from the operation of five small package treatment plants (Trestle Beach, Sand Dollar, Place De Mer, Canon Del Sol, Boulder Creek), one community leach field (Place de Mer), and a wastewater treatment lagoon (Davenport). Emissions from this sector increased between 2005 and 2010 by about 11 percent. This increase is attributable to an increase in the use of natural gas by the Santa Cruz County Sanitation District.

Santa Cruz County Sanitation District			
Year	Electricity (kWh)	Natural Gas (therms)	Emissions (MT CO_2e)
2005	3,100,652	2,690	**708**
2009	2,981,010	4,953	**804**

Source: County of Santa Cruz, 2013.

Package Treatment Plant Emissions (MT CO_2e)		
Facility	**2005**	**2009**
Davenport	81	81
Place de Mer	40	40
Boulder Creek	6	6
Sand Dollar	5	5
Canon Del Sol	5	5
Trestle Beach	1	1
Rolling Woods	1	N/A
Total	**140**	**138**
Source: County of Santa Cruz, 2013.		

Wastewater Treatment Summary (MT CO_2e)		
Function	**2005**	**2009**
Santa Cruz County Sanitation District	708	804
Package Treatment Plants	140	138
Totals	**848**	**942**
Source: County of Santa Cruz, 2013.		

Public Lighting

Emissions from electricity consumption for streetlights, and traffic control devices increased between 2005 and 2009 by about 11 percent. Because the number of these facilities did not change significantly, the increase can be attributed to an increase in the PG&E emission factor. This sector includes public lighting for which the County has direct operation control. The vast majority of streetlights throughout the County are under the control of PG&E.

2005 Public Lighting		
Source	**Electricity Use (kWh)**	**Emissions (MT CO_2e)**
Streetlights	108,086	24
Traffic Signals / Controllers	156,088	35
Other Outdoor Lighting	13,012	3
Total	**277,186**	**62**
Source: County of Santa Cruz, 2013.		

2009 Public Lighting		
Source	**Electricity Use (kWh)**	**Emissions (MT CO_2e)**
Streetlights	101,078	26
Traffic Signals / Controllers	164,160	43
Other Outdoor Lighting	N/A	N/A
Total	**265,238**	**69**
Source: County of Santa Cruz, 2013.		

Water Systems

This sector includes storm drain pumps, irrigation pumps, and the Davenport water treatment plant. These were grouped together due to the small size of this sector all related to water delivery. Emissions from this sector increased between 2005 and 2009 by about 33 percent. This can be attributed to a combination of factors including the increase in the PG&E emissions factor and an increase in electricity use for irrigation systems, both resulting from drought conditions.

2005 Water Systems		
Source	**Electricity Use (kWh)**	**Emissions (MT CO_2e)**
Irrigation Pumps	43,582	10
Stormwater Pumps	38,923	9
Davenport Water System	24,010	5
Total	**106,515**	**24**
Source: County of Santa Cruz, 2013		

2009 Water Systems		
Source	**Electricity Use (kWh)**	**Emissions (MT CO_2e)**
Irrigation Pumps	56,959	15
Stormwater Pumps	38,775	10
Davenport Water System	27,421	7
Total	**123,155**	**32**
Source: County of Santa Cruz, 2013.		

Community Greenhouse Gas Inventory

Inventories of community emissions for years 2005 and 2009 were originally prepared for the County of Santa Cruz by the Association of Monterey Bay Area Governments (AMBAG) Energy Watch Program. The Planning Department worked with AMBAG staff to validate the inventory information and ensure the inventories provide an accurate representation of community emissions that can be tracked over time.

The Community emissions inventory surveyed energy use and emissions in the three sectors of Transportation, Energy (Residential and Commercial/Industrial), and Solid Waste. The largest greenhouse gas (GHG) sector, responsible for 60 percent of total emissions was transportation, followed by the residential sector, then the commercial/industrial sector, with the solid waste sector contributing a relatively small amount. The Community inventory showed a total of 1,907,037 tons CO_2e in 2005, decreasing to 791,278 tons CO_2e in 2009, a 59 percent decrease in emissions. This is largely attributable to the closer of the Davenport cement plant in 2009.

The MBUAPCD tracks major emitters (those emitting >10,000 metric tons of criteria pollutants), and the MBUAPCD began quantifying GHG emissions from these facilities in 2008. Major emitters remaining in Santa Cruz County following the closure of the cement plant in include the asphalt plants at Felton Quarry and Olive Springs Quarry. Data regarding GHG emissions from the asphalt plants are included in the 2009 community inventory. Historical data was used to estimate GHG emissions from these facilities for the 2005 inventory to allow comparison of the overall inventories. It should be noted, however, there are numerous other commercial/industrial facilities that emit <10,000 metric tons of criteria pollutants that are not included in the inventory because the activity data is not available.

The community inventory does not include emissions from septic leach fields, and propane usage because of difficulty in obtaining accurate activity data in these areas. The inventories do include emissions from rail, air, and marine transportation.

Community Emissions by Sector

Sector	Metric Tons CO_2e Emitted		Percent Change from 2005 Baseline
	Year 2005	Year 2009	
Transportation	555,458	481,787	-13%
Residential	173,336	189,658	9%
Commercial and Industrial	1,158,119	**101,588**(1)	-91%(2)
Solid Waste	20,124	18,245	-9%
Total	**1,907,037**	**791,278**	**-59%**

Notes:

(1) This much lower number reflects the closure of the Davenport cement plant in 2008.

(2) A complete explanation of the change in the commercial/industrial sector is hampered by an inability to completely subtract the contribution from the cement plant from the 2005 inventory. Almost all of the emissions from the cement plant consist of stack emissions, with a portion of emissions resulting from electricity use (conveyor belt, etc.), which appears to have been a large amount of electricity relative to other electricity use in this sector. While stack emissions are known and can be eliminated, electricity data in this sector is not detailed enough to effectively eliminate use attributable to the cement plant. However, based on known economic conditions it is assumed that this sector as a whole, not counting the cement plant, still experienced some emission reduction between 2005 and 2009, probably due to the economic downturn.

Transportation

Transportation emissions accounted for about 60 percent of the community emissions in 2009 for the unincorporated portion of the County. Transportation emissions decreased approximately 13 percent between 2005 and 2009. The decrease is likely attributed to fewer VMT largely due to economic conditions, and to a

lesser extent greater overall fuel efficiency in the vehicle fleet. VMT data includes estimates of all vehicle miles traveled on public roadways within the unincorporated part of the County, including 600 miles of County maintained roads and all State Highways. Available data for travel on State highways represents vehicle miles traveled by residents of all the cities within the County, all residents outside of the cities (County residents), and other travelers passing through the County. A partial correction to the data was made to better represent vehicle miles traveled by just County residents. The available data was adjusted to reduce vehicle miles traveled by a percentage equal to the percentage of the County's population residing within the four cities with the County. This better represents vehicle miles traveled attributable to County residents.

2005 Transportation Sector Emissions Summary

Vehicle Class	Daily VMT	Percent VMT	Annual Emissions ($MT CO_2e$)
Passenger Cars	1,336,556	45.69%	205,759
Light-Duty Trucks	537,251	18.37%	99,233
Light-Duty Trucks	612,729	20.95%	112,916
Medium-Duty Trucks	235,763	8.06%	60,133
Light-Heavy-Duty	49,188	1.68%	16,506
Light-Heavy-Duty	28,410	0.97%	8,678
Medium-Heavy-Duty	44,524	1.52%	25,463
Heavy-Heavy-Duty	16,961	0.58%	11,439
Other Buses	2,120	0.07%	0
School Buses	3,392	0.12%	1,548
Urban Buses	9,329	0.32%	8,512
Motor Homes	13,569	0.46%	3,416
Motorcycles	35,619	1.22%	1,856
Total	2,925,412	100%	555,458

Source: County of Santa Cruz, 2013.

2009 Transportation Sector Emissions Summary

Vehicle Class	Daily VMT	Percent VMT	Annual Emissions ($MT CO_2e$)
Passenger Cars	1,244,156	45.77%	187,839
Light-Duty Trucks	507,731	18.68%	93,919
Light-Duty Trucks	524,630	19.30%	96,989
Medium-Duty Trucks	181,981	6.69%	45,497
Light-Heavy-Duty	32,367	1.19%	11,224
Light-Heavy-Duty	22,075	0.81%	7,241
Medium-Heavy-Duty	27,919	1.03%	15,549
Heavy-Heavy-Duty	3,804	0.14%	2,437
Other Buses	1,348	0.05%	0
School Buses	2,528	0.09%	1,154
Urban Buses	2,254	0.08%	2,244
Motor Homes	34,025	1.25%	11,643
Motorcycles	133,632	4.92%	6,051
Total	**2,718,451**	**100%**	**481,787**

Source: County of Santa Cruz, 2013.

Transportation Sector Emissions Summary		
Year	Daily VMT	Annual Emissions ($MT CO_2e$)
2005	2,925,412	**555,458**
2009	2,718,451	**481,787**
Source: County of Santa Cruz, 2013.		

Residential Emissions

This sector is comprised of emissions from residential gas and electric use. Activity data consists of aggregated PG&E records of electricity and natural gas usage for the residential sector in the unincorporated area of Santa Cruz County. Total emissions increased by over nine percent between 2005 and 2009. This can be attributed almost entirely to the increase in the PG&E emission factor between 2005 and 2009, and to a lesser degree to increased energy use in the residential sector. The following tables contain additional information on emissions factors and percent change to illustrate the relative effect of activity data and emissions factors on total emissions.

Residential Electricity			
Inventory	2005	2009	Percent Change
Consumption (kWh)	364,432,506	370,493,201	1.64%
Emissions Factor ($kgCO_2e$/kWh)	0.2237	0.2626	14.82%
Emissions ($MT CO_2e$)	81,532	96,261	15.30%
Note: Emissions in 2009 are lower than calculated using the emissions factors due to application of credits from the Climate-Smart program.			
Source: County of Santa Cruz, 2013.			

Residential Natural Gas			
Inventory	2005	2009	Percent Change
Consumption Therms	17,267,468	17,790,418	2.94%
Emissions Factor ($kgCO_2e$/Therm)	5.3166	5.3166	0.00%
Emissions ($MT CO_2e$)	91,804	93,396	1.70%
Note: Emissions in 2009 are lower than calculated using the emissions factors due to application of credits from the Climate-Smart program.			
Source: County of Santa Cruz, 2013.			

Residential Summary			
Inventory	2005	2009	Percent Change
Electricity	81,532	96,261	15.30%
Natural Gas	91,804	93,396	1.70%
Total	**173,336**	**189,657**	**9.42%**
Note: Emissions in 2009 are lower than calculated using the emissions factors due to application of credits from the Climate-Smart program.			
Source: County of Santa Cruz, 2013.			

Commercial/Industrial Emissions

This sector is comprised of emissions from gas and electric use by businesses and industry. This sector measures business and government's emissions from natural gas and electricity use, and from industrial and commercial processes subject to reporting requirements of the MBUAPCD. Facilities in Santa Cruz County subject to these reporting requirements include the asphalt plants at Felton Quarry and Olive Springs Quarry, and the Davenport cement plant. Emissions in this sector decreased 91 percent attributable almost entirely to the closer of the cement plant in 2009 and the elimination of emissions from burning coal. Some of the reduction in energy use seen in the PG&E records for the commercial/industrial sector could also be associated with the plant closure because the plant was also a large user of electricity.

Commercial / Industrial Electricity			
Inventory	**2005**	**2009**	**Percent Change**
Consumption kWh	237,292,724	207,829,820	-12%
Emissions Factor ($kgCO_2e$/kWh)	0.2237	0.2626	15%
Emissions (MT CO_2e)	65,585	56,578	-14%
Note: Emissions in 2009 are lower than calculated using the emissions factors due to application of credits from the Climate-Smart program.			
Source: County of Santa Cruz, 2013.			

Commercial / Industrial Natural Gas			
Inventory	**2005**	**2009**	**Percent Change**
Consumption Therms	8,126,493	8,230,344	1%
Emissions Factor ($kgCO_2e$/Therm)	5.3166	5.3166	0%
Emissions (MT CO_2e)	43,205	43,381	<1%
Note: Emissions in 2009 are lower than calculated using the emissions factors due to application of credits from the Climate-Smart program.			
Source: County of Santa Cruz, 2013.			

Point Sources			
Inventory	**2005**	**2010**	**Percent Change**
Davenport Cement Plant	1,047,417	0	-100%
Felton Quarry Asphalt Plant	1,212	923	-23%
Olive Springs Quarry Asphalt Plant	700	706	<1%
Total	1,049,329	1,629	-99%
Source: County of Santa Cruz, 2013.			

Commercial / Industrial Summary			
Inventory	**2005**	**2009**	**Percent Change**
Electricity	65,585	56,578	-14%
Natural Gas	43,205	43,381	<1%
Point Sources	1,049,329	1,629	-99%
Total	**1,158,119**	**101,588**	**-91%**
Source: County of Santa Cruz, 2013.			

Solid Waste

Emissions in this sector include an estimate of landfill gas not captured by the landfill gas recovery systems at the landfills. These are the same emissions accounted for in the government operations inventory, not including electricity and natural gas use associated with buildings and other facilities at the landfills, which were accounted for in the aggregate energy use data in the commercial/industrial sector.

Solid Waste Emissions (MT CO_2e)			
Source	**2005**	**2009**	**Percent Change**
Landfill Methane Emissions	20,124	18,245	9%
Source: County of Santa Cruz, 2013.			